6.0 DETAILED ANALYSIS OF SITEWIDE REMEDIAL ALTERNATIVES

The detailed analysis of sitewide remedial alternatives involves the evaluation of each remedial alternative according to the criteria defined in USEPA guidance[1] and the FS Work Plan[2]. These criteria were developed from the statutory requirements of Section 121 of CERCLA and the NCP. After assessing each alternative, a summary of the detailed analysis for that alternative is presented to describe how each alternative performs against the evaluation criteria. This summary will be utilized to make comparisons among alternatives in Section 7.

6.1 Evaluation Criteria

As discussed above, the evaluation criteria that were utilized to perform the detailed analysis of sitewide remedial alternatives are specified in USEPA guidance. Section 121 of CERCLA (as amended by SARA) specifies that the following factors be considered in assessing alternative remedial actions:

- the long-term uncertainties associated with land disposal;
- the goals, objectives, and requirements of the Solid Waste Disposal Act;
- the persistence, toxicity, mobility, and propensity to bioaccumulate of hazardous substances and their constituents;
- short- and long-term potential for adverse health effects from human exposure;

[1]USEPA, 1988c.

[2]Geraghty & Miller, 1990b.

- long-term maintenance costs;

- the potential for future remedial action costs if the alternative remedial action being considered were to fail; and

- potential threats to human health and the environment associated with excavation, transportation, and redisposal, or containment.

The nine evaluation criteria utilized in this analysis consider the above factors and are grouped into the following categories:

- Statutory Requirements

  - Compliance with ARARs
  - Overall Protection

- Technical, engineering, institutional and cost considerations.

  - Short-term Effectiveness
  - Long-term Effectiveness and Permanence
  - Reduction of Mobility, Toxicity, and Volume
  - Implementability
  - Cost

- Acceptance of Remedial Alternative

  - State Acceptance
  - Community Acceptance

Each of the above criteria is further divided into subcategories of criteria which are identified in Table 6-1. A definition of each of the evaluation criteria is presented in the following sections.

6.1.1 Statutory Requirements

The criteria associated with statutory requirements consider whether each alternative would meet the statutory requirements of CERCLA Section 121, and the NCP. These criteria are defined as follows:

- Compliance with ARARs - Addresses whether the remedial alternative complies with applicable or relevant and appropriate Federal and State requirements as defined in CERCLA Section 121.

- Overall protection - Addresses how the remedial alternative protects human health and the environment. This assessment focuses on how an alternative achieves protection over time and indicates how each source of contamination would be minimized, reduced, or controlled. The evaluation of the degree of overall protection associated with each remedial alternative is based largely on the exposure pathways and scenarios set forth in the Baseline Risk Assessment[3]. It should be noted that certain findings and conclusions of the baseline risk assessment are currently being re-evaluated. Therefore, discussions regarding the overall protection afforded by the remedial alternatives may require revision to reflect the findings and conclusions of the final baseline risk assessment.

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[3]Donohue & Associates, Inc., 1991a, 1991b.

TABLE 6-1

Summary of Evaluation Criteria for Detailed Analysis of Alternatives

	PRIMARY EVALUATION CRITERIA								
	Compliance with ARARs	Overall Protection	Short-Term Effectiveness	Long-Term Effectiveness	Reduction of Mobility, Toxicity, and Volume	Implementability	Cost	State Acceptance	Community Acceptance
Subcriteria	Compliance with chemical-specific ARARs	How alternative provides human health and environmental protection	Time until Protection is achieved	Reduction of existing risks	Amount of hazardous materials destroyed or treated	Ability to construct and operate the technology	Development and construction costs	Features of the alternative the state supports	Features of the alternative community supports
	Compliance with location-specific ARARs		Short-term reliability of technology	Magnitude of future risks	Degree of expected reductions in mobility, toxicity and volume	Ability to phase into operable units	Operating costs for implementing remedial action	Features of the alternative the state has reservations about	Features of the alternative community has reservation about
	Compliance with action-specific ARARs		Protection of community during remedial actions	Long-term reliability	Degree to which treatment is permanent	Ease of undertaking additional remedial actions, if necessary	Other capital and short-term costs until remedial action is complete	Elements of the alternative the state strongly opposes	Elements of the alternative community strongly opposes
	Compliance with other criteria, advisories, and guidancs (TBCs)		Protection of workers during remedial actions	Prevention of future exposure to residuals	Type and quantity of residuals remaining after treatment	Ability to monitor for effectiveness of remedy	Cost of operation and maintenance for as long as necessary		
				Potential need for replacement		Ability to obtain approvals from other agencies	Costs of 5-year reviews (if required)		
						Coordination with other agencies			
						Availability of treatment, storage, and disposal services and capacity			
						Availability of necessary equipment and specialists			

6.1.2 Technical, Engineering, Institutional, and Cost Considerations

The criteria associated with technical, engineering, institutional, and cost considerations are grouped together because they involve a more technical analysis in which a number of factors within each criteria are considered. These criteria are defined as follows:

- Short-term Effectiveness - Addresses potential human health and environmental impacts of the alternative during the construction and implementation phase until remedial response objectives are met.

- Long-term Effectiveness - Addresses the results of a remedial action in terms of the residual risk remaining at the site after the remedial objectives have been met.

- Reduction of Mobility, Toxicity, and Volume - Addresses the statutory preference for selecting remedial actions which include treatment technologies that permanently and significantly reduce the mobility, toxicity, or volume of hazardous substances present at the site.

- Implementability - Addresses the technical and administrative feasibility of implementing an alternative and the availability of services and materials required during implementation. Implementability is further categorized into technical feasibility, administrative feasibility, and availability criteria.

- Cost - Addresses the capital costs, the operation and maintenance costs, and a present worth analysis of all costs. The capital costs are divided into direct costs (construction) and indirect costs (non-construction and overhead). Direct capital costs include construction costs, equipment costs, land and site development costs, relocation expenses, and disposal costs. Indirect capital costs include engineering expenses, legal fees and license or permit costs, start-up costs, and contingency allowances.

Operation and maintenance (O&M) costs are post construction costs necessary to ensure the continued effectiveness of a remedial action. These costs include operating labor costs, maintenance materials and labor costs, auxiliary materials and energy, disposal of residues, purchased services, administrative costs, insurance, taxes, licensing costs, maintenance reserve and contingency funds, rehabilitation costs, and costs of periodic site reviews, if required. The cost estimates presented in this FS report were developed utilizing USEPA guidance[4], Means Site Work Cost Data[5], Means Building Construction Cost Data[6], cost compendiums[7], and quotations from various vendors. In accordance with USEPA guidance, the costs estimates in this FS have been prepared to provide an accuracy in the range of +50 to -30 percent. Cost estimates presented in this FS have been rounded to two significant figures to reflect the level of accuracy in the estimates. Unless otherwise noted, all capital and O&M cost estimates presented in this FS are expressed in 1993 dollars.

Allowances were made for certain direct and indirect capital cost items, including start-up/shakedown of the treatment systems associated with each alternative, and contingencies. The allowances for start-up/shakedown are expressed as a percentage (normally 5%) of the capital cost for the treatment components of the alternative under consideration. The contingency allowances are expressed as percentages (normally 20%) of the total capital cost for each alternative. The percentages for these allowances were derived from USEPA guidance on

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[4]USEPA, 1987.

[5]R.S. Means Co., Inc., 1991a.

[6]R.S. Means, Co., Inc., 1991b.

[7]Rischel, et. al., 1984.

estimating remedial action costs[8]. The USEPA guidance also specifies that contingency allowances be made for operating and maintenance over the life of the alternative. A contingency of 20 percent was applied to the O&M cost estimate for each alternative.

After development of the capital and operation and maintenance costs, a present worth analysis of the overall remedial action costs associated with each alternative was conducted. A present worth analysis relates costs that occur over different time periods to present costs by discounting all future costs to the present value. This allows the cost of remedial alternatives to be compared on the basis of a single figure that represents the capital required in current dollars to construct, operate, and maintain the remedial alternative throughout its planned life. In accordance with USEPA guidance, the present worth calculations in this FS are based on a discount rate of 10 percent, which represents the average rate of return on private investment, before taxes and after inflation[9].

6.1.3 Acceptance of Remedial Alternative

The criteria associated with the acceptance of a remedial alternative present the known and expected perception that others will have towards the remedial action. These criteria are defined as follows:

- State acceptance - Addresses the technical and administrative issues and from the State of Ohio's perspective. Pursuant to the Administrative Order on Consent, the State of Ohio has authority to comment, approve, and disapprove of all deliverables, including this FS, under the Order. This role does not abrogate the

[8]USEPA, 1987.

[9]USEPA, 1987.

State's opportunity to accept the proposed plan pursuant to the nine criteria presented in the NCP.

- Community acceptance - This criterion is intended to provide an opportunity to incorporate public input into the analysis of alternatives.

Because formal comments from the State and community are generally not received until after the RI and FS reports have been prepared and the proposed plan published, the State and community acceptance criteria will not be evaluated in this FS report. These criteria will be considered by the USEPA at the completion of the public comment period and addressed in the Record of Decision (ROD).

6.2 Remedial Alternative 1 (No-Action)

Remedial Alternative 1 constitutes the no-action alternative for the Ormet site. The various remedial measures and components that were assembled to form this remedial alternative are described in Section 5.2.

6.2.1 Compliance with ARARs

Implementation of Remedial Alternative 1 would not achieve compliance with chemical- and location-specific ARARs established for the Ormet site. Since this remedial alternative involves the absence of active remedial measures, there are no action-specific ARARs associated with Remedial Alternative 1.

6.2.2 Overall Protection

Implementation of Remedial Alternative 1 would not enhance protection of human health or the environment. The human health and environmental exposure pathways assumed in the Baseline Risk Assessment would not be blocked and the source materials present on-site would not be contained, treated, or destroyed under this remedial alternative.

6.2.3 Short-Term Effectiveness

This remedial alternative would provide essentially no short-term effectiveness. Current exposure pathways and risks as assumed in the Baseline Risk Assessment[10] would not be addressed in the short-term. Since this remedial alternative involves the absence of active remedial measures, there are no short-term reliability, worker protection, or environmental impact considerations associated with Remedial Alternative 1. There would be no increased protection of the community under this remedial alternative.

6.2.4 Long-Term Effectiveness

This remedial alternative would provide no long-term effectiveness. Existing risks and exposure pathways as assumed in the Baseline Risk Assessment would not be addressed over the long-term. The magnitude of future risks associated with implementation of this remedial alternative would be as calculated under the hypothetical future use scenarios described in the Baseline Risk Assessment. Since this remedial alternative involves the absence of active remedial measures, there are no long-term reliability or replacement considerations associated with Remedial Alternative 1. Future exposures under actual or hypothetical site use scenarios would not be prevented through implementation of Remedial Alternative 1.

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[10]Donohue and Associates, Inc., 1991a, 1991b.

This remedial alternative would not be effective in reducing infiltration through the affected media in the FSPSA, the FDPs, or the CMSD. Modelling of the infiltration that would occur at the FSPSA and the CMSD under existing conditions was performed using the Hydrologic Evaluation of Landfill Performance (HELP) Model[11] (see Appendix I and Appendix J). The existing slopes and soil types described in the RI report were used as input for the infiltration modelling. The results of the modelling indicate that approximately 33 percent of the total incident precipitation in the FSPSA would infiltrate through the soils in this area. Similarly, the modelling indicated that approximately 28 percent of the incident precipitation over the CMSD would infiltrate through the CMSD. In both cases, the remaining precipitation would be transported away from the area by surface water run-off or evapotranspiration. Based on these results, leachate would continue to be generated in these areas, but would be reduced to some degree.

The aquifer would not be restored in a reasonable amount of time under this alternative because pumping would be terminated and ground-water would not be treated.

The NCP states that a five year review would be needed whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, as per the NCP, a five year review would be required.

6.2.5 Reduction of Mobility, Toxicity, and Volume

Under this remedial alternative, none of the affected media present at the Ormet site would undergo treatment or destruction. Consequently, there would be no reductions in

[11]USEPA, 1988f.

constituent mobility and toxicity, or media volume under Remedial Alternative 1. Similarly, there would be no treatment residuals associated with this remedial alternative.

6.2.6 Implementability

Since this remedial alternative involves the absence of active remedial measures, there are no constructability and operability issues due to implementation of Remedial Alternative 1. This remedial alternative does not include monitoring of site conditions. However, long-term monitoring using the existing network of wells would not be effective because potential off-site migration would not be observable using these on-site wells. Approvals would not be needed for implementation of this remedial alternative. Additionally, skilled workers, specialized equipment, and off-site transportation and disposal services would not be needed under this alternative.

6.2.7 Costs

There would be no capital or O&M costs associated with implementation of this remedial alternative. Consequently, the present worth of this alternative is zero.

6.3 Remedial Alternative 2

Remedial Alternative 2 constitutes a containment alternative for the Ormet site. Remedial Alternative 2 was assembled by combining the following Remedial Measures:

- GW-3: Pumping of Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;

- SP-4: Collection of Ballfield and CMSD Seeps using Trench Drains, Treatment of CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-2: Containment by Vegetated Soil Cover;
- FDP-2: Containment by Vegetated Soil Cover;
- CMSD-3: Recontouring, and Vegetated Soil Cover;
- CRDA-3: Excavation, Consolidation and Containment by Vegetated Soil Cover; and
- SED-6: Sheet Piling Containment and Concrete Revetments.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.3.

6.3.1 Compliance with ARARs

The ability of Remedial Alternative 2 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.3.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat pumped ground water prior to surface water discharge. Specifically, effluent from the lime/ferrous salt precipitation treatment system would utilize BAT and would comply with NPDES effluent limitations that will be established for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale studies of this technology (See Appendix A). Fluoride concentration reductions were also achieved in the pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

This remedial alternative could achieve chemical-specific ARARs for aquifer quality. Containment of the former spent potliner storage area would reduce infiltration through the FSPSA, which is the primary source of on-site impacts to the quality of the alluvial aquifer. Similarly, containment of the former disposal ponds, which much less significantly impact the aquifer, would reduce infiltration through these areas. Continued extraction of the ground water by the existing interceptor wells would continue to remove contaminant mass from the alluvial aquifer. Ultimately, this combination of process options should result in attainment of MCLs and non-zero MCLGs.

Remedial Alternative 2 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and consolidated within the CMSD prior to capping of the CMSD. The carbonaceous material in the CRDA is not itself a hazardous waste, therefore, it would not be subject to LDRs as ARARs. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Carbonaceous material identical to that present in the CRDA is routinely sampled to determine whether it exhibits characteristics which would qualify it as a RCRA characteristic waste. This material has never exhibited hazardous characteristics.

6.3.1.2 Location-Specific ARARs

Remedial Alternative 2 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid wastes in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[12]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD

[12]USEPA, 1988d.

sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

6.3.1.3 Action-Specific ARARs

Operation of the Ormet Ranney well and the existing interceptor wells would be subject to certain action-specific ARARs under Remedial Alternative 2. Specific maintenance requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 2 would comply with these requirements.

Treatment of the interceptor well water under Remedial Alternative 2 would also be subject to action-specific ARARs. This remedial alternative would comply with the substantive provisions of any Permit-to-Install requirements, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Off-site landfilling of the ground-water treatment residuals would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 2 would comply with these requirements. Depending on the outcome of the waste characterization, Remedial Alternative 2 may be subject to various transportation and disposal requirements, including the LDRs.

The soil covers over the FSPSA, FDPs, and the CMSD would be in general accordance with federal ARARs for closure of areas utilized in conjunction with activities involving solid waste. Regulations promulgated under RCRA Subtitle D require that, "[c]over material shall be applied as necessary to minimize fire hazards, infiltration of precipitation, odors and blowing litter; control gas venting and vectors, discourage scavenging, and provide a pleasing appearance," (40 CFR Part 241.209-1). Remedial Alternative 2 would fully comply with these requirements. Furthermore, this alternative addresses all of the risks assumed in the Baseline Risk Assessment.

The State of Ohio solid waste regulations are more stringent than the Federal Subtitle D guidelines. The soil covers specified under this alternative would not attain the state ARARs for closure of areas utilized in conjunction with activities involving solid waste.

Covering of the CMSD under this remedial alternative would not necessitate explosive gas monitoring because construction materials are generally not putrescible. Wooden scrap that was emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. Even if the wood in the CMSD were to putrefy, the permeable nature of the cover would not cause accumulation of explosive concentration of gas. Air monitoring performed during test pit excavation in the CMSD did not detect the presence of explosive gases.

TSCA regulations do not establish action-specific ARARs for PCB-contaminated sediments. Clean up goals for sediments have been determined in accordance with TBC information identified by the USEPA. The cleanup goals for PCBs and PAHs calculated in Appendix F would not be attained under this alternative. However, installation of sheet piling and concrete revetments would eliminate or greatly reduce exposure pathways identified in the Baseline Risk Assessment.

6.3.2 Overall Protection

Remedial Alternative 2 would be protective of human health and the environment. The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;

- ingestion of contaminated media from all areas of concern; and

- direct contact with contaminated media from all areas of concern.

These exposure pathways would be effectively addressed under Remedial Alternative 2 for all areas.

Release of airborne dusts would be prevented by the physical barrier formed by the vegetated soil covers. Infiltration would be reduced significantly through regrading of the site and construction of the vegetated soil cover. These actions would promote runoff and evapotranspiration thereby reducing infiltration. The precipitation that does infiltrate might result in leaching of constituents. However, this would not result in residual exposure risks because the ground water would be contained on-site, extracted by the interceptor wells, and treated by the lime/ferrous salt precipitation treatment system to levels acceptable for surface water discharge. There would be no exposure to ground-water or soil constituents, therefore, the residual risk levels would be zero. Infiltration from the CMSD would be effectively contained by the impermeable silt/clay layer underlying the CMSD and collected by the trench drain along the toe of the CMSD. Any infiltration collected in this manner would also be treated, as necessary, to levels acceptable for surface water discharge. A second trench drain would collect water from the ballfield seep and this water would be monitored to confirm that the treatment of the water is not required prior to discharge to the Ohio River.

Exposure to sediments in the backwater area would be prevented or greatly reduced by the sheet piling and the concrete revetments. There would be no human exposure and zero risks associated with the backwater sediments. Exposure to the sediments in the Ohio River would be similar to the risks identified in the baseline risk assessment with the following differences. First, the construction of the sheet pile barrier, separating the backwater area from the Ohio River, would preclude future releases of PCBs and PAHs to the river. Background sediments would be deposited over the impacted sediments in a relatively short period of time, compared with the 70-year exposure that was used to calculate the baseline risk numbers. The resedimentation process would begin immediately following construction of the containment structures and would be continuous thereafter. Resedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Studies conducted by the Army Corps of Engineers (1991) indicate that unconsolidated materials used to "cap" contaminated sediments in-situ are generally resistant to erosion, even during storm events. Therefore, while the residual risk associated with the Ohio River sediments cannot be quantified, they are expected to be only a fraction of the risks identified in the baseline risk assessment because they would be eliminated in a relatively short period of time.

Potential ecological exposure and hazards that were identified in the baseline risk assessment would be reduced under alternative 2. The vegetative soil cover would significantly reduce the potential for exposure of small mammals and phytotoxicity. As discussed below, routine maintenance of the soil cover would include measures to prevent penetration of the soil cover by burrowing animals and trees. Given the absence of evidence of burrowing under existing conditions, the affected media beneath the vegetative soil cover may act as a natural deterrent to burrowing animals. Trees would also be controlled as part of the maintenance of the soil cover. The Ormet facility is an operating industrial facility with an existing maintenance staff. This staff would maintain the soil cover thus ensuring the environmental protection associated with this alternative. The vegetative soil cover would preclude or eliminate exposure to the waste material for most terrestrial organisms. Therefore, potential food-chain exposure associated with the soils would be addressed by alternative 2.

Remedial Alternative 2 would result in the removal of the backwater area as a potential source and exposure point for ecological receptors. Rerouting of the Outfall 004 drainage ditch, coupled with containment using sheet piling would eliminate the backwater area as a freshwater habitat. These actions would also prevent future release of constituents to the Ohio River. The concrete revetments that would be installed under this alternative would prevent exposure to the dried sediments in this area. The overall effect of these actions would be the prevention of exposure to constituents in the backwater area.

The potential for future releases of constituents from the backwater area to the Ohio River would be eliminated by the construction of the sheet pile barrier. Direct toxicity to aquatic organisms in the Ohio River was not identified in the baseline risk assessment. The elimination of future releases and the natural sedimentation processes in the river would combine to reduce or eliminate the potential for future exposure to the impacted sediments in the Ohio River. As the sediments are buried and/or the constituents in the sediments are degraded, the potential for food chain exposure would decrease. Exposure and hazards to the aquatic organisms are expected to decrease because of the elimination of the source and natural attenuation processes. As discussed previously, resedimentation is expected to be a relatively rapid process due to the site setting.

6.3.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 2 is described in the following sections.

6.3.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 2 could be achievable within two to four years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the interceptor wells represents current conditions. Effective treatment of the extracted ground-water from the interceptor wells would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 2 includes 19 months for engineering design and construction following issuance of a permit to install.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the CMSD seeps could be potentially completed within 1 to 2 years.

Remedial Alternative 2 involves several containment structures including steel sheet piling, vegetated soil layers, and concrete revetments. These structures could be constructed within 2 years. The estimated construction time for placement of the vegetated soil covers was developed assuming sequential placement in the former spent potliner storage area, the former disposal ponds, the CMSD, and containment of the Outfall 004 backwater area sediments.

6.3.3.2 Short-Term Reliability

Remedial Alternative 2 would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1958) and the interceptor wells (installed in 1972). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.3.3.1, approximately 19 months will be required for construction of the treatment system after issuance of the PTI under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the ground-water treatment component of this alternative is addressed in Section 6.3.4.3.

Containment of the former spent potliner storage area, the former disposal ponds, the CMSD, and the Outfall 004 backwater area sediments would be performed in the short-term. As discussed in Section 6.3.3.1, approximately 2 years will be required for placement of the vegetated soil cover in these areas. Therefore, containment of these areas would be initiated in the mid-term, and would continue over the long-term. The vegetated soil covers would be reliable over the short-term provided that periodic inspections and repairs are performed.

6.3.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The containment components of Remedial Alternative 2 will require regrading of the CMSD, former spent potliner storage area, and the former disposal ponds. Additionally, Remedial Alternative 2 involves excavation of the carbonaceous material in the CRDA and placement of these materials in the CMSD prior to capping of the CMSD. These earthmoving activities could potentially result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground-water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the ground-water extracted by the interceptor wells demonstrated that this water is not acutely toxic to aquatic organisms.

None of the treatment processes under this alternative will utilize acids or other reactive reagents which could potentially generate gases such as HCN during treatment. All treatment under this alternative will be performed at an alkaline pH. Therefore, there would not be any potential exposure to HCN during treatment, storage or disposal.

6.3.3.4 Worker Protection

Implementation of Remedial Alternative 2 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under

this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the CRDA to restrict fugitive dust emissions. Given the use of the dust suppressants, the amount of dust possibly generated cannot be estimated, but inhalation exposure during the period of excavation and transfer to the CMSD is expected to be minimal. Appropriate protective equipment would be utilized during the period of excavation and material handling to provide additional protection of the workers.

6.3.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and
- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppresants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

6.3.4 Long-Term Effectiveness

This remedial alternative would also be protective of human health and the environment over the long-term.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative consists of pumping of the Ormet Ranney well and existing interceptor wells to control and recover the plume, followed by treatment of the ground-water extracted by the interceptor wells using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground-water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in ground water in that portion of the alluvial aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years, under current site conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations is provided in Appendix K. Installation of the soil covers as source control measures under Remedial Alternative 2 is not expected to substantively alter this time frame.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the vegetated soil cover would promote run-off and evapotranspiration. Infiltration modelling was performed for the vegetated soil cover (see Appendices I and J). For the FSPSA, regrading and construction of the vegetated soil cover would only allow 22 percent of the incident precipitation to infiltrate. This equates to approximately a 32 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a vegetated soil cover would only allow 25 percent of the incident precipitation to infiltrate. Based on these results, leachate would continue to be generated in these areas, but would be reduced to some degree.

6.3.4.1 Reduction of Assumed Existing Risks

Implementation of Remedial Alternative 2 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the soils would be eliminated by the construction of the vegetated soil cover. Direct contact with the soils beneath the cover would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted soils beneath the vegetated soil cover, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the interceptor wells and treatment of the captured ground-water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the vegetated soil cover.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Construction of the sheet pile barrier between the Ohio River and the Outfall 004 backwater area would prevent future releases from the backwater area to the river. Concrete revetments would block direct exposure to the dried out sediments in this area. Human exposure to the sediments beneath the revetments would be precluded due to the size and weight of the revetments. The human exposure pathways to the dried sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would also be eliminated. Therefore, the risk to humans associated with ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater potential source area is isolated and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over a relatively short period of time as the sediments are covered by background river sediments. The Outfall 004 backwater would be isolated, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.3.4.2 Magnitude of Future Risks

Under Remedial Alternative 2, constituents in the alluvial ground water would be collected and treated. Future hypothetical exposure of plant workers, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated water as a source of potable drinking water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3 reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and the CMSD. Future exposure of child or adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential for exposure to any constituents that might still leach from the underlying media after the vegetated soil cover is installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

Vegetated soil covers on the former spent potliner storage area, the former disposal ponds, and the CMSD (with the consolidated carbonaceous material from the carbon run-off and deposition area) would prevent the emission of fugitive dust and eliminate direct contact exposure to the affected media. The vegetated soil covers over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. It is possible that the affected media may act as a deterrent to burrowing animal activity. The vegetated soil cover forms a physical barrier that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the routine maintenance of the vegetated soil cover would include control of burrowing animals and removal of seedling trees that might take root at the site. Infiltration through the vegetated soil cover could mobilize some of the constituents in the subsurface soils, however, as discussed in the preceding paragraph, these constituents would pose zero risks to humans or wildlife.

The revetments and sheet piling would significantly reduce the potential for future exposure to constituents in the sediments in the Outfall 004 backwater area, where exposure of aquatic organisms and humans would be eliminated or greatly reduced. Food chain exposures associated with the Outfall 004 backwater area would be eliminated concurrently with elimination of this area as a freshwater habitat. The elimination of this small area of benthic habitat is not consistent with the remedial action objective for the environment. In the Ohio River, the sheet piling would prevent the potential for future releases to the sediments of the river, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments. Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases. As discussed in Section 6.3.2, resedimentation is expected to be a relatively rapid process, due to the site setting, with the newly deposited sediments being generally resistant to erosion (Corps of Engineers, 1991).

In summary, the remedial measures that comprise Remedial Alternative 2 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.3.4.3 Long-Term Reliability

Remedial Alternative 2 would be reliable over the long-term. As discussed in Section 6.3.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the interceptor wells has performed reliably since their installation. In consideration of the in-line redundancy in the ground-water extraction system utilizing the interceptor wells, and ground-water containment utilizing the Ormet-Ranney well and the interceptor wells, over the long-term is expected to be highly reliable.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control.[13] Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

The vegetated soil covers over the former spent potliner storage area, the former disposal ponds, and the CMSD would also be reliable over the long-term. The soil cover over these areas would be subject to wind and water erosion, burrowing animals, and accidental or intentional intrusion. Periodic maintenance and repairs to the soil cover would be required to preserve the long-term reliability of the soil cover.

CERCLA requires a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required.

6.3.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney well and the interceptor wells will effectively contain the ground-water plume under the Ormet site. Treatment of the ground-water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce constituent concentrations in the extracted ground-water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. As discussed in Section 6.3.4, regarding the remediation of ground water, restoration of ground-water quality will

[13]Baker/TSA, Inc. 1990.

require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property. Placement of soil covers and installation of concrete revetments and sheet piling will eliminate the potential for direct contact exposure and prevent releases to the air. Therefore, Remedial Alternative 2 will eliminate or significantly reduce potential future exposures to the constituents present at the Ormet site.

6.3.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Potential for repair of the vegetated soil covers will be limited to periodic maintenance. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, baiting for animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the soil cover components.

6.3.5 Reduction of Mobility, Toxicity, and Volume

This remedial alternative would result in removal of constituents from the ground-water extracted by the interceptor wells, as well as for the CMSD seeps. No volume reductions would result from implementation of Remedial Alternative 2. The mobility of the various organic and inorganic constituents present in the various media at the site would not be reduced under this remedial alternative, although the containment barriers that would be provided under Remedial Alternative 2 would effectively block transport pathways.

6.3.5.1 Quantities Treated or Destroyed

Ground-water extracted by the interceptor wells is one of two media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground-water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the seeps along the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately 1.3 million gallons per year.

6.3.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot plant conditions to effluent concentrations of 0.19 to 0.89 mg/L[14]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced under carefully controlled pilot plant conditions to 10 to 15 mg/L[15]. This corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

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[14]Baker/TSA, Inc., 1990.

[15]Baker/TSA, Inc., 1990.

Under this remedial alternative, oils present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

In utilizing vegetated soil cover over the CMSD coupled with regrading, infiltration would be reduced, thus decreasing discharge from the seeps. The magnitude of this decrease is not known.

6.3.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the sludge would be removed from the system and disposed off-site. Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

6.3.5.4 Treatment Residuals

Treatment residuals resulting from the precipitation process consist of dewatered sludge. Baker/TSA, Inc. estimated that full scale operation would yield approximately 3 tons per day of dewatered sludge (filter cake)[16]. Samples of the sludge from the pilot plant were collected and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[17].

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[16]Baker/TSA, Inc., 1990.

[17]Baker/TSA, Inc., 1990.

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the absorber vessels. The amount of free-phase oil observed on the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5, it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

6.3.6 Implementability

Remedial Alternative 2 is potentially implementable within site conditions. The various implementability considerations associated with Remedial Alternative 2 are discussed in the following sections.

6.3.6.1 Constructability and Operability

This remedial alternative is both constructable and operable within site conditions. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance, and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by any of the existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps.

As discussed in Section 6.3.3.2, the ground-water extraction system has operated reliably since installation of the Ormet Ranney well and the interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

Pilot studies have demonstrated that treatment of the ground-water extracted by the interceptor wells requires careful process control[18]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation. Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

Construction of vegetated soil covers over the former disposal ponds would not pose undue engineering difficulties under this remedial alternative. Due to the fluidity of the underlying pond solids, the use of heavy equipment would need to be limited to prevent liquefaction of the crustal layer.

There are no operability considerations associated with the containment components of Remedial Alternative 2. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

6.3.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 2 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements could be managed as operable units:

- ground-water extraction and treatment;

[18]Baker/TSA, Inc., 1990.

- seep collection and treatment; and
- containment measures.

Several of these component remedial measures must be implemented sequentially. For example, excavation of the carbon run-off and deposition area must be performed prior to placement of a soil cover over the CMSD because the carbonaceous materials would be contained in the CMSD.

6.3.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 2 could be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water extraction system continues to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Periodic ground-water quality data will also provide the best means of adjusting projections of the time required to achieve reductions in contaminant concentrations.

Vegetated cover inspections would be performed to monitor the integrity of the soil cover. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized effectively to monitor the chemical composition and concentrations of the discharges.

Periodic inspections of the concrete revetments would be performed to ensure that no shifting or cracking of the revetment has occurred. Sediment sampling would not be performed.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The former disposal ponds, former spent potliner storage area, CMSD, CRDA, and sediments would not pose a problem, since these areas would be contained with no treatment. Additional remedial action for ground-water and the seeps would require modifications to the respective treatment systems. Changes of this nature would be difficult to implement.

6.3.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 2. Approvals would be required for construction of the ground-water treatment system for the interceptor well water that is included in this remedial alternative. Approval to construct this system would be in the form of a Permit-to-Install (PTI). Similarly, a PTI may be required for the CMSD seep collection and treatment system, and the ballfield seep collection system.

Approvals would also be required for discharges to surface-water under the National Pollution Discharge Elimination System (NPDES) program. The NPDES permit for the Ormet facility will govern discharges to surface water under this remedial alternative. Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.3.6.5 Availability of Off-Site Services and Capacity

Off-site transportation and disposal services would be required for the treatment residuals discussed in Section 6.3.5.4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these residuals exist within USEPA Region V[19]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. Due to the potential presence of PCBs in the oil, it has been assumed that the oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[20]. Adequate disposal capacity is commercially available.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 2. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

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[19]USEPA, et. al., 1990.

[20]USEPA, et. al., 1990.

6.3.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

Skilled workers and specialized equipment would not be required for installation of the soil cover for the former spent potliner storage are, the former disposal ponds, and the CMSD. Skilled workers and specialized equipment are also not required for the installation of concrete revetments under this remedial alternative.

6.3.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 2 are presented in this Section.

6.3.7.1 Capital Cost

The capital costs for Remedial Alternative 2 are summarized in Table 6-2. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Site-Wide Institutional Controls
- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3

Table 6-2. Summary of Capital Costs for Sitewide Remedial Alternative 2.

COST ELEMENT	REFERENCE TABLE	ESTIMATED COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment System	6-4	$1,823,000
3. Containment	6-5	$1,889,992
4. Seep Collection and Treatment System	6-7	$69,550
	SUBTOTAL	$3,863,550
Engineering/Design (10%)		$386,355
Installation/Shakedown (5%)		$94,628
	SUBTOTAL	$4,344,533
Contingency (20%)		$868,907
	SUBTOTAL	$5,213,740
Ground-Water Treatment O&M (years 1-10) {1}	6-10	$5,072,115
	TOTAL	**$10,285,855**
	ROUND	**$10,000,000**

{1} Reflects 10-year Present Worth Factor at 10%.

Table 6-3. Estimated Capital Costs for Sitewide Institutional Controls

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. ACCESS CONTROLS				
Fencing	4800	LF	$15.45	$74,160
Corner Posts	15	each	$86.50	$1,298
Gates (6)	1	LS	$2,050	$2,050
			SUBTOTAL	$77,508
2. DEED RESTRICTIONS	1	LS	$3,500	$3,500
3. SITE MONITORING{1}	--	--	--	--
			TOTAL	{2} $81,008
			ROUND	$81,000

{1} Estimate is based on utilization of on-site ground-water monitoring wells for site monitoring without supplementation by additional (new) wells.

{2} Indirect capital costs and contingencies for the institutional controls are included in the summary for overall remedial alternatives.

TABLE 6-4. Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3 {1}.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. EQUIPMENT				
Reactor Tank	1	each	$20,300	$20,300
Clarifier	1	each	$155,000	$155,000
Lime Slurry System	1	each	$84,200	$84,200
Ferrous Sulfate System	1	each	$79,600	$79,600
Polyelectrolyte System	1	each	$5,200	$5,200
Sludge Thickner	1	each	$42,000	$42,000
Sulfuric Acid Tank	1	each	$14,700	$14,700
Sludge Dewatering	1	each	$139,900	$139,900
Mixers (6)	1	LS	$74,700	$74,700
Pumps and Blowers (16)	1	LS	$53,000	$53,000
Diatomaceous Filter	1	each	$45,000	$45,000
Equalization Tank	1	each	$221,300	$221,300
			SUBTOTAL	$934,900
2. BUILDINGS				
Control Building	1	each	$242,300	$242,300
3. CONCRETE				
Containment Pad	1	LS	$122,800	$122,800
Foundations	1	LS	$20,700	$20,700
			SUBTOTAL	$143,500
4. INSTALLATION				
Instrumentation	1	LS	$128,700	$128,700
Electrical	1	LS	$135,200	$135,200
Mechanical (Piping)	1	LS	$80,400	$80,400
Site Preparation	1	LS	$158,000	$158,000
			SUBTOTAL	$502,300
			TOTAL {2}	**$1,823,000**
			ROUND	**$2,000,000**

{1} Baker/TSA, Inc., August 9, 1990. Costs for these items have not been indexed.

{2} Indirect capital costs and contingencies for the ground-water treatment system are included in the summaries for the overall remedial alternatives.

- Table 6-5: Estimated Capital Costs for Containment Under Remedial Alternative 2

- Table 6-6: Unit Costs Utilized for Estimating Containment Costs

- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System

6.3.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 2 are summarized in Table 6-8. The estimated annual O&M cost for sitewide institutional controls are presented in Table 6-9. The O&M costs for the ground-water extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M costs associated with the containment components of Remedial Alternative 2 are presented in Table 6-12.

6.3.7.3 Present Worth

The present worth of Remedial Alternative 2 was calculated to be $15,400,000. This value was calculated in accordance with USEPA guidance[21] utilizing an operating period of 30 years and a discount rate of 10 percent.

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[21]USEPA, 1987.

Table 6-5. Estimated Capital Costs for Containment Under Remedial Alternative 2.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. SEDIMENTS				
Concrete Revetments	27,000	SF	$4.00	$108,000
Steel Sheet Piling (Permanent)	3,000	SF	$40	$120,000
			SUBTOTAL	$228,000
2. SOIL COVER (CMSD)				
Regrading	90,000	CY	$8.23	$740,700
Borrow (Transport)	5,000	CY	$5.00	$25,000
Borrow (Placement)	5,000	CY	$9.82	$49,100
Rip-Rap	860	T	$31.85	$27,391
Hydroseeding	270,000	SF	$0.04	$10,800
			SUBTOTAL	$852,991
3. SOIL COVER (FDPs)				
Fill (Transport)	6,500	CY	$17.04	$110,760
Fill (Placement)	28,600	CY	$2.08	$59,488
Borrow (Transport)	15,200	CY	$5.00	$76,000
Borrow (Placement)	15,200	CY	$9.82	$149,264
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$428,232
4. SOIL COVER (FSPSA)				
Fill (Transport)	5,000	CY	$11.36	$56,800
Fill (Placement)	11,200	CY	$2.08	$23,296
Borrow (Transport)	11,300	CY	$5.00	$56,500
Borrow (Placement)	11,300	CY	$9.82	$110,966
Hydroseed	610,000	SF	$0.04	$24,400
			SUBTOTAL	$271,962
5. CONSOLIDATE CRDA IN CMSD				
Clearing/Grubbing	4.5	acre	$2,800	$12,600
Excavation	5,700	CY	$6.15	$35,055
Borrow (Transport)	3,600	CY	$5.00	$18,000
Borrow (Placement)	3,600	CY	$9.82	$35,352
Hydroseeding	195,000	SF	$0.04	$7,800
			SUBTOTAL	$108,807
			TOTAL {1}	**$1,889,992**
			ROUND	**$1,900,000**

{1} Indirect capital costs and contingencies for the containment systems are included in the summary for overall remedial alternatives.

Table 6-6. Unit Costs Utilized for Estimating Containment Costs.

COST ELEMENT	COST	SOURCE
Fill (Ash)	$6.00/CY	Vendor Inquiry
Hydroseed	$0.04/SF	Vendor Inquiry
40 mil HDPE Membrane	$0.50/SF	Vendor Inquiry
Geonet	$0.26/SF	Vendor Inquiry
10 oz. Geotextile	$0.18/SF	Vendor Inquiry
Rip-rap	$31.85/TON	Vendor Inquiry
Concrete Revetments	$4.00/SF	Vendor Inquiry
Steel Sheet Piling		
Permanent	$40.00/SF	Vendor Inquiry
Temporary	$46.00/SF	Vendor Inquiry
Fill Transport (FDP)	$17.04/CY	Means, 1993 (1)
Fill Transport (FSPSA)	$11.36/CY	Means, 1993 (1)
Fill Placement	$2.08/CY	Means, 1993 (1)
Borrow Transport	$5.00/CY	Vendor Inquiry
Borrow Placement	$9.82/CY	Means, 1993 (1)
Excavation	$6.15/CY	Means, 1993 (1)
Regrading	$8.23/CY	Means, 1993 (1)
Clearing/Grubbing	$2,800/acre	Means, 1993 (1)

(1) Means Site Work and Landscape Cost Data 1993, 12th Annual Edition, R.S. Means Company, Inc., Kingston, MA

Table 6-7. Estimated Capital Costs for Seep Collection and Treatment System.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. TRENCH CONSTRUCTION				
CMSD Collection Trench	1	LS	$8,000	$8,000
Ballfield Collection Trench	1	LS	$8,000	$8,000
			SUBTOTAL	$16,000
2. EQUIPMENT				
Oil/Water Separator	1	each	$7,100	$7,100
Carbon Adsorbers	3	each	$550	$1,650
Transfer Pumps	3	each	$400	$1,200
			SUBTOTAL	$9,950
3. CONCRETE				
Foundations	1	LS	$4,400	$4,400
Containment Pad	1	LS	$10,000	$10,000
(for separator)			SUBTOTAL	$14,400
4. INSTALLATION				
Instrumentation				$1,500
Electrical				$9,700
Mechanical (Piping)				$18,000
			SUBTOTAL	$29,200
			TOTAL {1}	$69,550
			ROUND	$70,000

{1} Indirect capital costs and contingencies for the seep collection and treatment system are included in the summaries for the remedial alternatives.

Table 6-8. Summary of O&M Costs for Sitewide Remedial Alternative 2.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
	SUBTOTAL	$961,570
Administration (12%)		$115,388
	SUBTOTAL	$1,076,958
Contingency (20%)		$215,392
	TOTAL	$1,292,350
	ROUND	$1,300,000

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR) 30 Year Operation with Ground-Water Treatment O&M for Years 1-10 Included in Capital Cost of Alternative.	$5,400,000

Table 6-9. Estimated Annual O&M Costs for Sitewide Institutional Controls.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. MAINTENANCE				
Perimeter Fence{1}				$2,325
2. SITE MONITORING				
Sampling Labor	400	man-hr	$40	$16,000
Analysis{2}				$10,000
			SUBTOTAL	$26,000
			TOTAL	**$28,325**
			ROUND	**$28,000**

{1} Based on 3% of installed cost for fence and appurtenances ($77,508) per Table 6-3.

{2} Based on analysis of 14 wells for the following parameters:

Three Times Annually

pH	Fluoride
TDS	CN(total)
TOC	Arsenic
Spec. Cond.	

Once Annually

pH	Sodium
TDS	Calcium
TOC	Iron
Spec. Cond.	Magnesium
Fluoride	Manganese
CN(total)	Sulfate
Arsenic	Silica
Aluminum	

Table 6-10. Estimated Annual O&M Costs for Ground-Water Treatment Under Remedial Measure GW-3 {1}.

COST ELEMENT	ESTIMATED ANNUAL QUANTITY	UNIT	UNIT COST	ANNUAL TOTAL COST
1. CHEMICALS				
Ferrous Sulfate Heptahydrate	314	ton	$183	$57,462
Hydrated Lime	252	ton	$251	$63,252
Sulfuric Acid	522	ton	$96	$50,112
Polyelectrolyte	2,215	lb	$27	$59,805
Diatomaceous Earth	219,000	lb	$0.21	$45,990
			SUBTOTAL	$276,621
2. UTILITIES				
Electricity	751,900	Kwh	$0.06	$45,114
Electricity (Ormet Ranney Well)	980,250	Kwh	$0.06	$58,815
Electricity (Interceptor Wells)	163,400	Kwh	$0.06	$9,804
			SUBTOTAL	$113,733
3. RESIDUALS DISPOSAL				
Sludge	1,107	ton	$280	$309,960
4. LABOR				
Treatment Plant Operation	2,912	man-hr	$25	$72,800
Ormet Ranney Well	1	LS	$3,500	$3,500
Interceptor Wells	1	LS	$2,100	$2,100
			SUBTOTAL	$78,400
5. MAINTENANCE				
Process Equipment (5% TEC{2})				$46,745
			TOTAL {3}	$825,459
			ROUND	$830,000

{1} Baker/TSA/Inc., August 9, 1990.

{2} Based on Total Equipment Cost ($934,900) per Table 6-4.

{3} Indirect costs and contingencies for O&M of the ground-water treatment systems are included in the summaries for the remedial alternatives.

Table 6-11. Estimated Annual O&M Costs for Seep Collection and Treatment.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. CHEMICALS				
Activated Carbon	4,800	lb	$1	$4,800
2. UTILITIES				
Electricity	9,800	Kwh	$0.06	$588
3. RESIDUALS DISPOSAL				
Free-Phase Oil	2	drum	$350	$700
Spent Activated Carbon	4,800	lb	$1.50	$7,200
			SUBTOTAL	$7,900
4. LABOR				
Carbon Change-Out	32	man-hr	$25	$800
Monitoring	208	man-hr	$25	$5,200
			SUBTOTAL	$6,000
5. MAINTENANCE				
Process Equipment (5% TEC{1})				$498
			TOTAL {2}	$19,786
			ROUND	$20,000

{1} Based on Total Equipment Costs ($9950) per Table 6-7.

{2} Indirect costs and contingencies for O&M of the seep collection and treatment system are included in the O&M summaries for the remedial alternatives.

Table 6-12. Estimated Annual O&M Costs for Containment.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. LABOR				
Quarterly Inspections and Reporting{1}	64	man-hr	$125	$8,000
2. MAINTENANCE				
Mowing and Repairs	1	LS	$80,000	$80,000
			TOTAL {2}	$88,000

{1} Assumes inspections and reports would be performed and prepared by licensed professional engineer.

{2} Indirect costs and contingencies for O&M of the containment system are included in the O&M summaries for the remedial alternatives.

6.4 Remedial Alternative 3

Remedial Alternative 3 constitutes a second containment alternative for the Ormet site. This Alternative was assembled by combining the following remedial measures:

- GW-3: Pumping of the Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;
- SP-4: Collection of Ballfield and CMSD Seeps Using Trench Drains, Treatment of CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-4: Containment by Single Barrier Synthetic Cap;
- FDP-5: Containment by Single Barrier Synthetic Cap;
- CMSD-4: Recontouring and Containment by Single Barrier Synthetic Cap;
- CRDA-3: Excavation, Consolidation and Containment by Single Barrier Synthetic Cap; and
- SED-8: Partial Dredging, Treatment by Solidification, Consolidation with CMSD, and Containment.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.4.

6.4.1 Compliance with ARARs

The ability of Remedial Alternative 3 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.4.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat pumped ground water prior to surface-water discharge. Specifically, effluent from the lime/ferrous salt precipitation treatment system would utilize BAT and would comply with NPDES effluent limitations that will be established for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale demonstrations of this technology. Fluoride concentrations were also achieved in the pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

Containment of the former spent potliner storage area, the former disposal ponds, and the CMSD, coupled with ground-water extraction by the existing interceptor wells should ultimately achieve chemical-specific ARARs for aquifer quality (i.e., MCLs and non-zero MCLGs).

Remedial Alternative 3 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and consolidated within the CMSD prior to capping of the CMSD. The carbonaceous material in the CRDA is not itself a listed hazardous waste. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Prior to removal and consolidation in the CMSD, the CRDA material would be appropriately characterized to determine its status relative to the LDRs.

6.4.1.2 Location-Specific ARARs

Remedial Alternative 3 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid wastes in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[22]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

[22]USEPA, 1988d.

6.4.1.3 Action-Specific ARARs

Operation of the Ormet Ranney well and the current interceptor wells would be subject to certain action-specific ARARs under Remedial Alternative 3. Specific maintenance requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 3 would comply with these requirements. Treatment of the interceptor well water under Remedial Alternative 3 would also be subject to action-specific ARARs. This remedial alternative would comply with the substantive requirements of any Permit-to-Install, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Off-site landfilling of the ground-water treatment residuals would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 3 would comply with these requirements. Depending on the outcome of the waste characterization, Remedial Alternative 3 may be subject to various transportation and disposal requirements, including the LDRs.

The single barrier caps that would be constructed over the former disposal ponds, the former spent potliner storage area, and the CMSD would attain or exceed the State of Ohio Solid Waste ARARs. As provided in OAC-3745-27-11(G)(1), the cap designs illustrated in Section 5 would include materials of construction that are comparable to those identified under OAC 3745-27-08 and 3745-27-11.

Capping the CMSD under this remedial alternative would not necessitate explosive gas monitoring plan because construction materials are generally not putrescible. Wooden scrap that was emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. If the wooden scrap in the CMSD was found to be putrescible, the accumulation of gas under the impermeable barrier could be controlled using passive gas vents. The need for gas controls would be evaluated during remedial design. Air monitoring performed during test pit excavation in the CMSD did not detect the presence of explosive gases.

Containment measures for the sediments in the Outfall 004 backwater area under this alternative may not attain TBC-based clean-up goals regarding PCBs, depending upon the concentrations of PCBs in the sediments removed from the backwater area. The cleanup goals for PCBs and PAHs that are provided in Appendix F would not be attained by the partial dredging of the backwater area. Under this alternative, soils containing greater than 25 mg/kg PCBs and greater than 370 mg/kg total PAHs would be excavated from the backwater area. The excavated materials from the backwater area would be treated and contained in the CMSD under a single barrier cap. If concentrations of PCBs in the dredged sediments exceed 50 mg/kg, a TSCA-compliant cell may need to be constructed within the CMSD. Containment of the excavated materials in this manner would attain substantive requirements for chemical waste landfilling under TSCA. Following removal, the excavated area would be sampled to confirm that the cleanup goals for PCBs and PAHs under this alternative have been achieved.

6.4.2 Overall Protection

The protectiveness of Remedial Alternative 3 for human health and the environment would be very similar to Remedial Alternative 2, except for sediments in the Outfall 004 backwater area. In this area, rerouting of the outfall stream, coupled with the dredging of sediments and the placement of revetments, would result in temporary disruption of benthic habitat. Environmental goals would be met by resedimentation and the associated restoration of benthic habitat.

The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;
- ingestion of contaminated media from all areas of concern;
- direct contact with contaminated media from all areas of concern;

These exposure pathways would be effectively addressed under Remedial Alternative 3 for all areas.

6.4.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 3 is described in the following sections.

6.4.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 3 could be achievable within two to four years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the existing interceptor wells represents current conditions. Effective treatment of the ground-water extracted by the interceptor wells would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 3 includes 19 months for engineering design and construction following issuance of a permit to install.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the CMSD seeps could be potentially completed within 1 to 2 years. Furthermore it is possible that the seeps would eventually disappear with the capping of the CMSD.

Coordination of dredging activities with the Army Corps of Engineers and compliance with the substantive permit requirements under this remedial alternative may extend the timeframe for achieving protection. The extent of this increase in the time required for implementation is not known, but may be on the order of one to three years.

Remedial Alternative 3 involves several containment structures, including single barrier synthetic caps, steel sheet piling, and concrete revetments. These structures could be constructed within 2 to 3 years. The estimated construction time for capping was developed assuming sequential capping of the former spent potliner storage area, the former disposal ponds, the CMSD, and containment of the Outfall 004 backwater area sediments.

6.4.3.2 Short-Term Reliability

Remedial Alternative 3 would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1958) and the interceptor wells (installed in 1972). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.4.3.1, approximately 19 months (after issuance of a permit to install) will be required for construction and shakedown of the treatment system under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the ground-water treatment component of this alternative is addressed in Section 6.4.4.3.

Containment of the former spent potliner storage area, the former disposal ponds, the CMSD, and the Outfall 004 backwater area sediments would not be performed in the short-term. As discussed in Section 6.4.3.1, approximately 2 to 3 years will be required for containment of these areas. Therefore, containment of these areas would be initiated in the mid-term, and would continue over the long-term. The reliability of this component of Remedial Alternative 3 is addressed in Section 6.4.4.3.

6.4.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The containment components of Remedial Alternative 3 will require regrading of the CMSD, former spent potliner storage area, and the former disposal ponds. Additionally, the sediments in the Outfall 004 backwater area would be dredged and the carbonaceous material in the CRDA would be excavated and placed under the cap in the CMSD. These earthmoving activities could potentially result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground-water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the ground-water extracted by the interceptor wells demonstrated that this water is not acutely toxic to aquatic organisms.

There is no possibility that implementation of this alternative would generate toxic gases. Ground-water treatment would be performed at alkaline pH, therefore the generation of HCN gas is not possible. None of the other treatment or containment components of this alternative would result in the possible generation of toxic reaction by-products.

6.4.3.4 Worker Protection

Implementation of Remedial Alternative 3 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under

this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the CRDA to restrict fugitive dust emissions. Partial dredging of the Outfall 004 backwater sediments is not expected to generate significant dust unless the sediments are allowed to dry at which point dust suppressants may also be used on the sediments. Given the use of dust suppressants, the amount of dust possibly generated cannot be estimated, but inhalation exposure during the period of excavation and transfer to the CMSD is expected to be minimal. Appropriate protective equipment would be utilized during the period of excavation and material handling to provide additional protection of the workers.

6.4.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and
- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppresants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

6.4.4 Long-Term Effectiveness

This remedial alternative would also be protective of human health and the environment over the long-term. The long-term effectiveness that would result from implementation of Remedial Alternative 3 is evaluated in the following sections.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative will consist of pumping of the Ormet Ranney well and existing interceptor wells to control and recover the plume, followed by treatment of the ground water extracted by the interceptor wells using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in ground water in that portion of the alluvial aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years under current site conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations, is provided in Appendix K.

Installation of the single barrier synthetic caps as source control measures under Remedial Alternative 3 is expected to decrease this time frame, as infiltration of precipitation through the unsaturated soils would be virtually eliminated. However, due to the fluctuations in the water table elevation over time and the consequent contact of ground water with unflushed soils, the extent to which aquifer restoration times may be reduced by the caps is uncertain.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the single barrier caps would promote run-off and evapotranspiration. Infiltration modelling was performed for the single barrier caps (see Appendices I and J). For the FSPSA, regrading and construction of the single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to approximately a 99.5 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to a 99.4 percent reduction over existing conditions. Based on these results, leachate generation in these areas would be virtually eliminated.

6.4.4.1 Reduction of Assumed Existing Risks

Similar to Remedial Alternative 2, implementation of Remedial Alternative 3 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the soils would be eliminated by the construction of the single barrier cap. Direct contact with the soils beneath the cap would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted soils beneath the single barrier cap, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the interceptor wells and treatment of the captured ground-water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the single barrier cap.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Partial dredging of the Outfall 004 backwater area to remove constituents followed by placement of concrete revetments over the remaining sediments would prevent direct exposure to constituents in sediments and prevent future releases from the backwater area to the river. Concrete revetments would prevent erosion and block direct exposure to the dried sediments that would remain in this area. Human exposure to the sediments beneath the revetments would be precluded due to the size and weight of the revetments. The human exposure pathways to the backwater sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would also be eliminated. Therefore, the risk to humans associated with ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater area is dredged and contained with the concrete revetments, and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over time as the sediments are covered by background river sediments. Constituents in the Outfall 004 backwater area would be removed or contained beneath the concrete revetments, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.4.4.2 Magnitude of Future Risks

Under Remedial Alternative 3, constituents in the alluvial ground water would be collected and treated similar to Remedial Alternative 2. Future hypothetical exposure of plant workers, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated ground water as a source of potable water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3, reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and the CMSD. Future exposure of child or adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential for exposure to any constituents that might still leach from the underlying media after the single barrier cap is installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

Single barrier synthetic caps on the former spent potliner storage area, the former disposal ponds, and the CMSD (with the consolidated carbonaceous material from the carbon run-off and deposition area and the dredged sediments from the Outfall 004 backwater area) would prevent the emission of fugitive dust and eliminate direct contact exposure to the impacted soils. The single barrier caps over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. With the exception of deep burrowing animals, the single barrier caps would preclude exposure of most terrestrial organisms. It is possible that the affected media may also act as a deterrent to burrowing animal activity. The single barrier cap forms a physical barrier that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the maintenance of the single barrier cap would include control of burrowing animals through baiting and removal of seedling trees that might take root at the site. Infiltration through the single barrier cap could mobilize some of the constituents in the subsurface soils, however, as discussed in the preceding paragraph, these constituents would pose zero risks to humans or wildlife.

Because the 004 Backwater area is an embayment of the Ohio River, relocation of 004 outfall stream prior to sediment removal and placement of revetments would not eliminate benthic habitat. Placement of the revetments would temporarily disrupt the benthic habitat in the backwater area. However, because the backwater area is an embayment, resedimentation and the associated restoration of benthic habitat would occur relatively rapidly. Studies performed by the U.S. Army Corps of Engineers (1991) indicate that in-situ capping can be an effective method of providing long-term isolation of contaminated sediments. The overall effect of these actions would be that exposure to constituents in the backwater area would be eliminated or greatly reduced. Food chain exposures associated with the Outfall 004 backwater area would be essentially eliminated. Partial dredging of the Outfall 004 backwater area and placement of concrete revetments would significantly reduce the potential for future releases to the Ohio River, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments. Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases.

In summary, the remedial measures that comprise Remedial Alternative 3 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.4.4.3 Long-Term Reliability

Remedial Alternative 3 would be reliable over the long-term. As discussed in Section 6.4.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the existing interceptor wells has performed reliably since their installation. In consideration of the in-line redundancy in the ground-water extraction system utilizing the existing interceptor wells, and ground-water containment utilizing the Ormet Ranney wells and the interceptor wells over the long-term is expected to be highly reliable.

Long-term reliability of single barrier caps utilizing synthetic membrane materials of construction has been proven, dependent upon adequate post-closure maintenance. The reliable life expectancy of a standard (i.e., single barrier) landfill cap with normal maintenance is approximately 50 to 100 years (Versar, Inc., 1991). Caps employing synthetic materials of construction are susceptible to punctures, tears, and freezing temperatures, mainly during construction. Proper QA/QC during cap construction can greatly reduce the potential for damage to the cap. Standard engineering practice of installing geotextile fabric between the vegetated layer and drainage layer, coupled with vegetating the cover with grasses that do not have deep roots, will aid in preventing root penetration. Burrowing animals that currently live on-site would be controlled (OAC 3745-27-11 (G)(4)). The geotextile fabric and geonet will also aid in preventing animals from burrowing into the cap. A well-maintained vegetative cover, periodic inspections and limited site access will ensure reliable long-term performance of the single barrier caps. Synthetic membranes exhibit a high degree of resistance to chemical contact and are capable of elongating up to 500 percent (National Sanitation Foundation Standard Number 54). Unless atypical settlement or depressions develop, the integrity of a synthetic membrane cap will not be compromised by settlement.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control.[23] Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

Vendor literature indicates that materials used for concrete revetments are reliable over the long-term. The fabric envelope is immune to attack by mild acids and alkalis, organic solvents and biological organisms, and will protect against erosion damage. Concrete revetments are expected to be reliable over the long-term.

CERCLA requires a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required.

[23]Baker/TSA, Inc. 1990.

6.4.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney well and the interceptor wells will effectively contain the ground-water plume under the Ormet site. Treatment of the ground-water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce constituent concentrations in the extracted ground-water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. As discussed in Section 6.4.4, regarding the remediation of ground water, restoration of ground-water quality will require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property.

The single barrier synthetic cap that would be provided over the CMSD under this remedial alternative will reduce the potential for infiltration and transport of constituents from the CMSD. Pumping and treating of the alluvial ground-water, capping with single barrier synthetic caps, and concrete revetments over the Outfall 004 backwater area sediments will eliminate direct contact exposure, prevent releases to the air, and can effectively eliminate infiltration and transport. Therefore, Remedial Alternative 3 will eliminate or significantly reduce future exposure to the constituents present at the Ormet site.

6.4.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Similarly, the highly durable materials utilized in concrete revetments would not be likely to require replacement over the long-term. Potential for repair of single barrier caps utilizing synthetic membrane materials of construction will be limited to periodic maintenance of the soil cover. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, control of burrowing animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the cap components.

6.4.5 Reduction of Mobility, Toxicity, and Volume

This remedial alternative would result in removal of constituents for the ground-water extracted by the interceptor wells, as well as for the CMSD seeps. No volume reductions would result from implementation of Remedial Alternative 3. The mobility of the various organic and inorganic constituents present in the various media at the site would not be reduced under this remedial alternative, although the containment barriers that would be provided under Remedial Alternative 3 would effectively block transport pathways.

6.4.5.1 Quantities Treated or Destroyed

Ground-water extracted by the interceptor wells is one of two media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground-water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the seeps along the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately

1.3 million gallons per year. However, it is possible that the seeps would eventually disappear with capping of the CMSD.

Approximately 1,000 CY of sediments will be solidified and consolidated with the CMSD prior to capping under Remedial Alternative 3.

6.4.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot plant operations to effluent concentrations of 0.19 to 0.89 mg/L[24]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced to 10 to 15 mg/L[25]. This corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

Under this remedial alternative, oils present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

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[24]Baker/TSA, Inc., 1990.

[25]Baker/TSA, Inc., 1990.

In utilizing a single barrier cap over the CMSD coupled with regrading, infiltration would be reduced thus eliminating or significantly decreasing generation of the seeps. Following capping, the seeps may stop discharging entirely.

6.4.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the sludge would be removed from the system and disposed off-site Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

6.4.5.4 Treatment Residuals

Treatment residuals resulting from the precipitation process consist of dewatered sludge. Baker/TSA, Inc. estimated that full scale operation would yield approximately three tons per day of dewatered sludge (filter cake)[26]. Samples of the sludge from the pilot plant were collected and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[27].

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the absorber vessels. The amount of free-phase oil observed on the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5,

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[26]Baker/TSA, Inc., 1990.

[27]Baker/TSA, Inc., 1990.

it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

Solidification of the sediments from Outfall 004 backwater area will also generate treatment residuals. The solidified material will increase from 25 to 75 percent by volume, resulting in 1,300 to 1,800 CY (Table 6-13). As previously discussed in Section 6.4.5, the solidified material will be placed in the CMSD prior to construction of the single barrier cap over the CMSD.

6.4.6 Implementability

Remedial Alternative 3 is potentially implementable within site conditions.

6.4.6.1 Constructability and Operability

This remedial alternative is both constructable and operable within site conditions. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance, and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by any of the existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps.

Table 6-13. Estimated Volumetric Increases Under Stabilization/Solidification Process.

AREA	IN-SITU VOLUME (CY)	SOLIDIFIED VOLUME (CY)	
		(30% Swell)	(50% Swell)
Pond 1	8,400	10,920	12,600
Pond 2	6,100	7,930	9,150
Pond 3	13,500	17,550	20,250
Pond 4	17,800	23,140	26,700
Pond 5	370,000	481,000	555,000
Sediments - Backwater Area Partial Dredge	1,000	1,300	1,750
Sediments - Backwater Area Complete Dredge	2,000	2,600	3,000
Sediments - Backwater Area & River Dredge	5,500	7,150	8,250

As discussed in Section 6.4.3.2, the ground-water extraction system has operated reliably since installation of the Ormet Ranney well and the existing interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

Pilot studies have demonstrated that treatment of the ground-water extracted by the interceptor wells requires careful process control[28]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation. Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

Construction of single barrier caps utilizing synthetic membrane as the barrier layer would require specialized equipment for welding the seams of the membrane. This equipment would be utilized under the supervision of a qualified specialty installer. Construction of single barrier synthetic caps over the former disposal ponds would not pose undue engineering difficulties under this remedial alternative. Due to the fluidity of the underlying pond solids, the use of heavy equipment would need to be limited to prevent liquefaction of the crustal layer.

The sediments from the Outfall 004 backwater area could potentially be dredged in the following manner. A crawler-mounted clamshell could be maneuvered to the toe of the CMSD. This equipment would dredge the sediments from the Outfall 004 backwater area and place them on top of the CMSD for drying and solidification. Once situated on top of the CMSD, earthmoving equipment could be utilized to solidify the sediments with lime and flyash. Treatability studies would be performed to determine the proper mixing ratio of sediments with binding agent for solidification.

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[28]Baker/TSA, Inc., 1990.

There are no operability considerations associated with the containment components of Remedial Alternative 3. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

6.4.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 3 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements could be managed as operable units:

- ground-water extraction and treatment;
- seep collection and treatment; and
- containment measures.

Several of these component remedial measures must be implemented sequentially. For example, excavation of the carbon run-off and deposition area must be performed prior to capping of the CMSD because the carbonaceous materials would be contained in the CMSD. Similarly, excavation of the carbon run-off and deposition area must be performed prior to dredging and placement of concrete revetments in the Outfall 004 backwater area because the outfall drainage ditch would be rerouted through the carbon run-off and deposition area.

6.4.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 3 could be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water extraction system continues to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Periodic ground-water quality data will also provide the best means of adjusting projections of the time required to achieve reductions in contaminant concentrations.

Cap inspections would be performed quarterly to monitor the integrity of the cap barrier. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding, and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized effectively to monitor the chemical composition and concentrations of the discharges.

Periodic inspections of the concrete revetments would be performed to ensure that no shifting or cracking of the revetment has occurred. No sediment sampling will be performed.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The former disposal ponds, former spent potliner storage area, CMSD, and CRDA would not pose a problem, since these areas would be contained with no treatment. Additional remedial actions for ground water and the seeps would require modifications to the treatment systems. Changes of this nature would be difficult to implement. Sediments would be dredged for consolidation within the CMSD and stabilized, which would result in increased volume. After stabilization the area would be capped, thus further remedial action on the sediments would be difficult.

6.4.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 3. Approvals would be required for construction of the ground-water treatment system for the interceptor wells that is included in this remedial alternative. Approval to construct this system would be in the form of a Permit-to-Install. Similarly, a PTI may be required for the CMSD seep collection and treatment system, and for the ballfield seep collection system.

Approvals would also be required for discharges to surface-water under the NPDES program. The NPDES permit for the Ormet facility will govern discharges to surface water under this remedial alternative. Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.4.6.5 Availability of Off-Site Services and Capacity

Off-site transportation and disposal services would be required for the treatment residuals discussed in Section 6.4.5.4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these residuals exist within USEPA Region V[29]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. Due to the potential presence of PCBs in the oil, it has been assumed that the

[29]USEPA, et. al., 1990.

oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[30]. Adequate disposal capacity is commercially available.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 3. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

6.4.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

Specialized equipment and skilled workers would be required for installation of the single barrier caps under this remedial alternative. However, the required materials and services are available through a variety of commercial sources.

Skilled workers would not be required for installation of concrete revetments over the sediments in the Outfall 004 backwater area. Installation of steel sheet piling as an operational control during dredging of the Outfall 004 backwater area would require specialized equipment.

[30]USEPA, et. al., 1990.

Pile driving equipment and the required personnel are available for both land-driven and barge-driven installations.

6.4.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 3 are presented in this Section.

6.4.7.1 Capital Cost

The capital costs for Remedial Alternative 3 are summarized in Table 6-14. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Sitewide Institutional Controls
- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3

Table 6-14. Summary of Capital Costs for Sitewide Remedial Alternative 3.

COST ELEMENT	REFERENCE TABLE	ESTIMATED COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment	6-4	$1,823,000
3. Seep Collection and Treatment System	6-7	$69,550
4. Containment	6-15	$4,677,642
5. Sediment Dredging	6-16	$224,000
	SUBTOTAL	$6,875,200
Engineering/Design (10%)		$687,520
Installation/Shakedown (5%)		$94,628
	SUBTOTAL	$7,657,349
Contingency (20%)		$1,531,470
	SUBTOTAL	$9,188,819
Ground-Water Treatment O&M (years 1-10) {1}	6-10	$5,072,115
	TOTAL	**$14,260,934**
	ROUND	**$14,000,000**

{1} Reflects 10-year Present Worth Factor at 10%

- Table 6-6: Estimated Unit Costs Utilized for Estimating Containment Costs
- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System
- Table 6-15: Estimated Capital Costs for Containment Under Remedial Alternative 3
- Table 6-16: Estimated Capital Costs for Sediment Dredging and Solidification Under Remedial Measure SED-8

6.4.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 3 are summarized in Table 6-17. The O&M costs for the ground-water extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M costs associated with the containment components of Remedial Alternative 3 are presented in Table 6-12.

Table 6-15. Estimated Capital Costs for Containment Under Remedial Alternative 3.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. CONCRETE REVETMENTS	13,500	CY	$4.00	$54,000
2. <u>SINGLE BARRIER CAP (CMSD)</u>				
Fill (Placement)	5,000	CY	$2.08	$10,400
Grading	90,000	CY	$8.23	$740,700
Membrane (40 mil HDPE)	270,000	SF	$0.50	$135,000
Geonet	270,000	SF	$0.26	$70,200
Geotextile (10 oz.)	540,000	SF	$0.18	$97,200
Borrow (Transport)	13,000	CY	$5.00	$65,000
Borrow (Placement)	13,000	CY	$9.82	$127,660
Rip-Rap	860	T	$31.85	$27,391
Hydroseeding	270,000	SF	$0.04	$10,800
			SUBTOTAL	$1,284,351
3. <u>SINGLE BARRIER CAPS (FDPs)</u>				
Fill (Transport)	21,700	CY	$17.04	$369,768
Fill (Placement)	43,750	CY	$2.08	$91,000
Membrane (40 mil HDPE)	818,000	SF	$0.50	$409,000
Geonet	818,000	SF	$0.26	$212,680
Geotextile (10 oz.)	818,000	SF	$0.18	$147,240
Borrow (Transport)	39,400	CY	$5.00	$197,000
Borrow (Placement)	39,400	CY	$9.82	$386,908
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$1,846,316
4. <u>SINGLE BARRIER CAP (FSPSA)</u>				
Fill (Transport)	16,300	CY	$11.36	$185,168
Fill (Placement)	22,500	CY	$2.08	$46,800
Membrane (40 mil HDPE)	610,000	SF	$0.50	$305,000
Geonet	610,000	SF	$0.26	$158,600
Geotextile (10 oz.)	1,220,000	SF	$0.18	$219,600
Borrow (Transport)	30,000	CY	$5.00	$150,000
Borrow (Placement)	30,000	CY	$9.82	$294,600
Hydroseed	610,000	SF	$0.04	$24,400
			SUBTOTAL	$1,384,168
5. <u>CONSOLIDATE CRDA IN CMSD</u>				
Clearing/Grubbing	4.5	acre	$2,800.00	$12,600
Excavation	5,700	CY	$6.15	$35,055
Borrow (Transport)	3,600	CY	$5.00	$18,000
Borrow (Placement)	3,600	CY	$9.82	$35,352
Hydroseeding	195,000	SF	$0.04	$7,800
			SUBTOTAL	$108,807
			TOTAL {1}	**$4,677,642**
			ROUND	**$4,700,000**

{1} Indirect capital costs and contingencies for the containment system are included in the summary for overall remedial alternatives.

Table 6-16. Estimated Capital Costs for Sediment Dredging and Solidification Under Remedial Measure SED-8.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. CONSOLIDATE SEDIMENTS IN CMSD				
Steel Sheet Piling (Temporary)	3,000	SF	$46	$138,000
Silt Curtains	1	LS	$40,000	$40,000
Dredging	1,000	CY	$33	$33,000
			SUBTOTAL	$211,000
2. SOLIDIFICATION				
Flyash (Transport)	1,000	CY	$6.00	$6,000
Flyash (Placement)	1,000	CY	$2.08	$2,080
Flyash (Mixing)	2,000	CY	$2.46	$4,920
			SUBTOTAL	$13,000
			TOTAL {1}	**$224,000**
			ROUND	**$220,000**

{1} Indirect capital costs and contingencies for sediment dredging are included in the summary for overall remedial alternatives.

Table 6-17. Summary of O&M Costs for Sitewide Remedial Alternative 3.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
	SUBTOTAL	$961,570
Administration (12%)		$115,388
	SUBTOTAL	$1,076,958
Contingency (20%)		$215,392
	TOTAL	$1,292,350
	ROUND	$1,300,000

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
30 Year Operation with Ground-Water Treatment O&M for Years 1-10 Included in Capital Cost of Alternative	$5,400,000

6.4.7.3 Present Worth

The present worth of Remedial Alternative 3 was calculated to be $19,400,000. This value was calculated in accordance with USEPA guidance[31] utilizing an operating period of 30 years and a discount rate of 10 percent.

6.5 Remedial Alternative 4

Remedial Alternative 4 constitutes a treatment and containment alternative for the Ormet site. This alternative was assembled by combining the following remedial measures:

- GW-3: Pumping of Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;
- SP-4: Collection of Ballfield and CMSD Seeps Using Trench Drains, Treatment of CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-3: Containment by Dual Barrier Cap;
- FDP-7: Solidification and Containment by Dual Barrier Cap;
- CMSD-5: Recontouring and Containment by Dual Barrier Cap;
- CRDA-3: Excavation, Consolidation, and Containment by Dual Barrier Cap; and
- SED-7: Complete Dredging, Solidification, Consolidation with CMSD, and Containment.

[31]USEPA, 1987.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.5.

6.5.1 Compliance with ARARs

The ability of Remedial Alternative 4 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.5.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat ground water pumped from the existing interceptor wells prior to discharge to the Ohio River. Specifically, effluent from the lime/ferrous salt precipitation treatment system would utilize BAT and would comply with NPDES effluent limitations that will be established for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale studies of this technology. Fluoride concentration reductions were also achieved in the pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

Containment of the former spent potliner storage area, containment and solidification of the former disposal ponds, and ground-water extraction should ultimately achieve chemical-specific ARARs (i.e., MCLs and non-zero MCLGs) in the alluvial aquifer. The RI concluded that the former disposal ponds are contributing to altered ground-water conditions much less significantly than the former spent potliner storage area. While the timeframe for achieving these goals under Remedial Alternative 4 could potentially be reduced by immobilization of the constituents in the pond solids through solidification, Remedial Alternative 4 may not have a significant effect on the timeframe for achieving MCLs and MCLGs in the alluvial aquifer.

Remedial Alternative 4 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and consolidated within the CMSD prior to capping of the CMSD. The carbonaceous material in the CRDA is not itself a hazardous waste, therefore, it would not be subject to LDRs as ARARs. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Carbonaceous material identical to that present in the CRDA is routinely sampled to determine whether it exhibits characteristics which would qualify it as a RCRA characteristic waste. This material has never exhibited hazardous characteristics.

6.5.1.2 Location-Specific ARARs

Remedial Alternative 4 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid wastes in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[32]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently

[32]USEPA, 1988d.

situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

6.5.1.3 Action-Specific ARARs

Operation of the Ormet Ranney well and the existing interceptor wells would be subject to certain action-specific ARARs under Remedial Alternative 4. Specific maintenance requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 4 would comply with these requirements.

Treatment under Remedial Alternative 4 would also be subject to action-specific ARARs. This remedial alternative would comply with the substantive requirements of any Permit-to-Install, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Off-site landfilling of the ground-water treatment residuals would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 4 would comply with these requirements. Depending on the outcome of the waste characterization, Remedial Alternative 4 may be subject to various transportation and disposal requirements, including the LDRs.

The dual barrier caps that would be constructed over the CMSD, the former disposal ponds, and the former spent potliner storage area would attain RCRA Subtitle C and State of Ohio ARARs pertaining to the closure of hazardous waste facilities. The cap designs illustrated in Section 5 would meet, or be equivalent to, the cap construction requirements specified under 40 CFR264.228 and 310 and OAC 3745-56-28 and OAC3745-57-10.

Capping the CMSD under this remedial alternative would not necessitate explosive gas monitoring because construction materials are generally not putrescible. Wooden scrap that was emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. If the wooden scrap in the CMSD putrefies, the accumulation of gas under the barrier layers could be controlled using passive gas vents. Air monitoring performed during test pit excavation in the CMSD did not detect the presence of explosive gases.

Containment measures for the sediments in the Outfall 004 backwater area under this alternative would attain action-specific ARARs regarding PCBs. Additionally, the cleanup goals for PCBs and PAHs identified in Appendix F would be attained in the backwater area under this alternative through complete dredging. Under this alternative, sediments containing PCBs and PAHs at concentrations greater than the SQCs (see Appendix F) would be excavated from the backwater area. Furthermore, the excavated materials from the backwater area would be treated and contained in the CMSD under a double barrier cap. Containment of the excavated materials in this manner would attain substantive requirements for chemical waste landfilling under TSCA. Following removal, the excavated area would be sampled to confirm that the PCBs had been completely removed.

6.5.2 Overall Protection

The protectiveness of Remedial Alternative 4 for human health and the environment would be very similar to Remedial Alternative 3. The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;

- ingestion of contaminated media from all areas of concern;

- direct contact with contaminated media from all areas of concern;

These exposure pathways would be effectively addressed under Remedial Alternative 4 for all areas.

6.5.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 4 is described in the following sections.

6.5.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 4 could be achievable within three to five years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the existing interceptor wells represents current conditions. Effective treatment of the extracted ground-water from the interceptor wells would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 4 includes 19 months for engineering design and construction following issuance of a permit to install.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the CMSD seeps could be potentially completed within 1 to 2 years. Furthermore, it is possible that the seeps would eventually disappear with capping of the CMSD.

Remedial Alternative 4 includes solidification of the solids in the former disposal ponds prior to capping, and solidification of the dredged sediments from the Outfall 004 backwater area prior to consolidation with the CMSD and capping. Processing rates for in-situ solidification using backhoes for mixing are approximately 1200 CY per eight hour day[33]. Solidification of the pond solids would therefore required approximately 1 to 2 years. Solidification of the 1,000 CY of excavated sediments from the Outfall 004 backwater area would be performed ex-situ

[33]Cullinane, et. al, 1986.

using the same equipment that would be employed for solidification of the pond solids. The time required to solidify the dredged sediments could be very short.

Administrative requirements concerning dredging activities under this remedial alternative may extend the timeframe for achieving protection. The extent of this increase in the time required for implementation is not known, but may be on the order of one to three years.

Remedial Alternative 4 also involves several containment structures including dual barrier caps, and steel sheet piling. These structures could be constructed within 2 to 3 years. The estimated construction time for capping was developed assuming sequential capping of the former spent potliner storage area, the former disposal ponds, and the CMSD.

6.5.3.2 Short-Term Reliability

Remedial Alternative 4 would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1953) and the existing interceptor wells (installed in 1972). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.5.3.1, approximately 19 months (after issuance of a permit to install) will be required for construction of the treatment system under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the ground-water treatment component of this alternative is addressed in Section 6.5.4.3.

Solidification of the pond solids and sediments and containment of the former spent potliner storage area, the former disposal ponds, and the CMSD would not be performed in the short-term. As discussed in Section 6.5.3.1, approximately 1 to 2 years will be required for solidification of the pond solids and sediments. Approximately 2 to 3 years will be required for containment of these areas. Therefore, solidification and containment of these areas would be initiated in the mid-term, and would continue over the long-term. The reliability of this component of Remedial Alternative 4 is addressed in Section 6.5.4.3.

Under Remedial Alternative 4, the sediments would be contained using silt curtains and sheet piling during dredging. The currents of the Ohio River during high flow periods (March)[34] would not be suitable for deployment of silt curtains. Literature indicates that silt curtains work best when the currents are less than one knot. Since containment would be needed near the bank of the Ohio River and the site is situated on the inside of a meander, the current at the site may not exceed one knot. Silt curtains may, therefore, be effective in controlling the transport of sediments during dredging. Both of these operational controls are effective in the short-term. Sediments captured by the barriers would be removed and disposed of properly.

6.5.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The treatment and containment components of Remedial Alternative 4 will require regrading of the CMSD, former spent potliner storage area, and the former disposal ponds, and solidification of the solids in the former disposal

[34]U.S. Army Corps of Engineers, 1991.

ponds and sediments. Additionally, the sediments in the Outfall 004 backwater area would be dredged and the carbonaceous material from the CRDA would be excavated and placed in the CMSD prior to capping of the CMSD. These earthmoving activities could potentially result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground-water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the Outfall 004 water, which includes untreated ground-water extracted by the existing interceptor wells, demonstrated that this water is not acutely toxic to aquatic organisms.

The silt curtains and sheet piling that would be utilized as operational controls during dredging will reduce the transport of resuspended sediments. Therefore, these operational controls will aid in protecting the community during dredging operations.

There is no possibility that implementation of this alternative would generate toxic gases. Ground-water treatment would be performed at alkaline pH, therefore, the generation of HCN gas is not possible. None of the other treatment or containment components of this alternative would result in the possible generation of toxic reaction by-products.

6.5.3.4 Worker Protection

Implementation of Remedial Alternative 4 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under

this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the CRDA to restrict fugitive dust emissions. Partial dredging of the Outfall 004 backwater sediments is not expected to generate significant dust unless the sediments are allowed to dry, at which point dust suppressants may also be used on the sediments. Given the use of dust suppressants, the amount of dust possibly generated cannot be estimated, but inhalation exposure during the period of excavation and transfer to the CMSD is expected to be minimal. Appropriate protective equipment would be utilized during the period of excavation and material handling to provide additional protection of the workers.

6.5.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and
- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppressants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

6.5.4 Long-Term Effectiveness

This remedial alternative would be protective of human health and the environment over the long-term.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative includes ground-water remedial measure GW-3, which consists of pumping of the Ormet Ranney well and the existing interceptor wells to control and recover the plume, followed by treatment of the ground-water extracted by the existing interceptor wells using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in ground water in that portion of the alluvial aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years under current site conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations, is provided in Appendix K.

Installation of the dual barrier caps as source control measures under Remedial Alternative 4 FSPSA is expected to decrease this time frame, as infiltration of precipitation through the unsaturated soils would be virtually eliminated. However, due to fluctuations in the water table elevation over time and the consequent contact of ground water with unflushed soils, the extent to which aquifer restoration times may be reduced by the caps is uncertain.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the dual barrier caps would promote run-off and evapotranspiration. Infiltration modelling was performed for the dual barrier caps (see Appendices I and J). For the FSPSA, regrading and construction of the single barrier cap would not allow any significant percentage of the incident precipitation to infiltrate. This equates to greater than a 99.9 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a dual barrier cap would also not allow any significant percentage of the incident precipitation to infiltrate. This also equates to a greater than 99.9 percent reduction over existing conditions. Based on these results, leachate generation in these areas would be virtually eliminated.

6.5.4.1 Reduction of Assumed Existing Risks

Similar to Remedial Alternative 2, implementation of Remedial Alternative 4 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the soils would be eliminated by the construction of the dual barrier cap. Direct contact with the media beneath the caps would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted soils beneath the dual barrier cap, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the existing interceptor wells and treatment of the captured ground-water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the dual barrier cap.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Dredging of the Outfall 004 backwater area to remove constituents would prevent direct exposure to constituents in sediments and prevent future releases from the backwater area to the river. The human exposure pathways to the backwater sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would also be eliminated. Therefore, the risk to humans associated with ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater area is contained and dredged, and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over time as the sediments are covered by background river sediments. Constituents in the Outfall 004 backwater area would be removed or contained beneath the concrete revetments, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.5.4.2 Magnitude of Future Risks

Similar to Remedial Alternative 2, constituents in the alluvial ground water would be collected and treated under Remedial Alternative 4. Future hypothetical exposure of plant workers, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated ground water as a source of potable water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3, reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and CMSD. Future exposure of child or adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential exposure to any constituents that might leach from the underlying media after the dual barrier caps are installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

Dual barrier caps on the former spent potliner storage area, the former disposal ponds, and the CMSD (with the consolidated carbonaceous material from the carbon run-off and deposition area and the dredged sediments) would prevent the emission of fugitive dust and eliminate direct contact exposure to the impacted media. The dual barrier caps over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. The dual barrier cap forms a physical barrier that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the maintenance of the dual barrier cap would include control of burrowing animals through baiting and removal of seedling trees that might take root at the site.

Because the 004 backwater area is an embayment of the Ohio River, relocation of the 004 outfall stream prior to sediment removal would not eliminate benthic habitat. Dredging of the sediments would temporarily disrupt the benthic habitat in the backwater area. However, because the backwater area is an embayment, resedimentation and the associated restoration of benthic habitat would occur relatively rapidly. The overall effect of these actions would be that exposure to constituents in the backwater area would be eliminated.

Food chain exposures associated with the Outfall 004 backwater area would also be eliminated. Dredging of the 004 backwater area would eliminate the potential for future releases to the Ohio River, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments. Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases.

In summary, the remedial measures that comprise Remedial Alternative 4 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.5.4.3 Long-Term Reliability

Remedial Alternative 4 would be reliable over the long-term. As discussed in Section 6.5.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the interceptor wells has performed reliably since installation of these wells. In consideration of the in-line redundancy in the ground-water extraction system, ground-water containment over the long-term is expected to be highly reliable.

Solidified materials are subject to breakdown due to natural weathering. Cullinane suggests that a minimum unconfined compressive strength of 50 pounds per square inch (psi) be considered as a measure of adequate bonding for solidified materials. Durability standards have not been established for solidified wastes, however, a 15 percent weight loss is considered to be an acceptable amount. Sulfate-rich ground-water can cause swelling and disintegration of Portland-cement/flyash-solidified waste. Additionally, leaching by rainwater can remove buffering materials in a solidified waste and allow the pH to drop such that metals are solubilized by the contacting water[35]. Capping the former disposal ponds would minimize degradation of the solidified material.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control[36]. Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

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[35]Cullinane, et.al, 1986.

[36]Baker/TSA, Inc. 1990.

Long-term reliability of dual barrier caps utilizing clay and/or synthetic membrane materials of construction has been proven, dependent upon adequate post-closure maintenance. The relative life expectancy of a dual barrier (i.e., RCRA) cap with normal maintenance is approximately 50 to 100 years (Versar, Inc., 1991). These caps are susceptible to settlement and cracking, wind and water erosion, root penetration, burrowing animals, and accidental or intentional intrusion. Proper QA/QC during cap construction and routine inspections and maintenance can reduce damage to the cap. Standard engineering practice of installing geotextile fabric between the vegetated layer and drainage layer, coupled with vegetating the cover with grasses that do not have deep roots, will aid in preventing root penetration. Animals that currently live on-site would be controlled prior to capping (OAC 3745-27-11 (G)(4)). The geotextile fabric and geonet will also aid in preventing the animals from burrowing into the cap. A well-maintained vegetative cover, periodic inspections and limited site access will ensure reliable long-term performance of the dual barrier caps.

CERCLA requires a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required.

6.5.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney and the interceptor wells will effectively contain the ground-water plume under the Ormet site. Treatment of the ground-water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce the constituent concentrations in the extracted ground-water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. As discussed in Section 6.5.4, regarding the remediation of ground water, restoration of ground-water quality will require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property.

Containment with dual barrier caps will eliminate the potential for direct contact exposure, prevent releases to the air, and can affectively eliminate infiltration and transport. Therefore, Remedial Alternative 4 will eliminate or significantly reduce potential future exposures to the constituents present at the Ormet site.

6.5.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Potential for repair of dual barrier caps will be limited to periodic maintenance of the soil cover. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, baiting for animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the cap components.

6.5.5 Reduction of Mobility, Toxicity, and Volume

This remedial alternative would result in removal of constituents for the ground-water extracted by the interceptor wells, as well as for the CMSD seeps. No volume reductions would result from implementation of Remedial Alternative 4. Solidification of the solids in the former disposal ponds and the sediments would be performed primarily to improve geotechnical properties. Solidification would increase the volume of these materials by 25 to 75 percent. Under Remedial Alternative 4, the 370,000 CY of solids present in Pond 5 would increase to approximately 460,000 to 650,000 CY (Table 6-13). Due to the volumetric increase resulting from solidification, additional material would not be required to fill the ponds to grade for capping under this remedial alternative. Secondarily, the immobility of the various organic and inorganic constituents present in the solids from the former disposal ponds and sediments could be enhanced to some extent depending upon the solidification agents selected. Constituent mobility would not be reduced for the former spent potliner storage area and CMSD. However, the containment barriers that would be provided for these areas under Remedial Alternative 4 would effectively block transport pathways.

6.5.5.1 Quantities Treated or Destroyed

Ground-water extracted by the interceptor wells is one of several media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground-water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately 1.3 million gallons per year.

As discussed in Section 2.4, the former disposal ponds contain approximately 420,000 CY of solids that will be solidified prior to capping. Approximately 2,000 CY of sediments will be solidified and consolidated with the CMSD prior to capping under Remedial Alternative 4.

6.5.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot scale conditions to effluent concentrations of 0.19 to 0.89 mg/L[37]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced to 10 to 15 mg/L[38]. This corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

Under this remedial alternative, oils present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

In utilizing a dual barrier cap over the CMSD coupled with regrading, infiltration would be reduced thus eliminating or significantly decreasing generation of the seeps. Following capping, the seeps may stop discharging entirely.

6.5.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the

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[37]Baker/TSA, Inc., 1990.

[38]Baker/TSA, Inc., 1990.

sludge would be removed from the system and disposed off-site. Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

Reduction of the solidified materials can cause the resolubilization of metals. Natural weathering can also cause the solidified material to physically disintegrate as mechanical strength is reduced through chemical reactions. Standards have not been established for performing durability tests on solidified waste materials. However, a 15 percent weight loss can be experienced[39]. The barriers that would be installed over the solidified residuals under Remedial Alternative 4 would aid in preventing these effects on the solidified materials within the former disposal ponds.

6.5.5.4 Treatment Residuals

Treatment residuals resulting from the lime/ferrous salt precipitation component of Remedial Alternative 4 consist of dewatered sludge. Baker/TSA, Inc. estimated that full scale operation would yield approximately three tons per day of dewatered sludge (filter cake)[40]. Samples of the sludge from the pilot plant were collected and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[41].

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the absorber vessels. The amount of free-phase oil observed on

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[39]USEPA, 1989i.

[40]Baker/TSA, Inc., 1990.

[41]Baker/TSA, Inc., 1990.

the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5, it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

Solidification of the pond solids and the sediments from Outfall 004 backwater area will also generate treatment residuals. The solidified material will increase from 30 to 50 percent by volume, resulting in 542,000 to 625,000 CY (Table 6-13). As previously discussed in Section 6.5.5, the solidified material in the former disposal ponds will serve to bring the ponds to grade prior to construction of the dual barrier caps over the former disposal ponds.

6.5.6 Implementability

Remedial Alternative 4 is potentially implementable within site conditions. The implementability considerations associated with Remedial Alternative 4 are discussed in the following sections.

6.5.6.1 Constructability and Operability

This remedial alternative is operable within site conditions, but poses certain constructability problems due to the solids in Pond 5. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance, and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by any of the existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps.

Under Remedial Alternative 4, solidification of the materials in the former disposal ponds would be accomplished using backhoes, crawler-mounted injector-type mixers or a vertical auger mixer/injector[42]. Because of the size of Pond 5, clamshell or dragline equipment would probably be required to ensure an adequate reach for mixing the contents of Pond 5 with the solidifying agents. Access for this type of equipment would be difficult along the berm of Pond 5 bordering the Ohio River due to the narrowness of the berm. To address the equipment access problem, Pond 5 could potentially be solidified by working progressively from the side adjacent to the former spent potliner storage area toward the river. This progressive approach would not prohibit the use of the equipment described above. Clamshell and dragline equipment for this purpose is available. The lime and fly ash reagents that would be used for solidification under Remedial Alternative 4 are available in the Ohio River valley region. Treatability studies would be required to determine appropriate mixing ratio of the materials in the former disposal ponds with lime and fly ash for solidification. Prior to capping, the solidified materials in the former disposal ponds would be regraded to provide adequate slopes for surface water run-off.

Construction of dual barrier caps would require specialized equipment and skilled personnel. The synthetic membrane barrier layer requires specialized equipment for welding the seams of the membrane. This equipment would be utilized under the supervision of a qualified specialty installer. Installation of the concrete revetments under CMSD-5 would require specialized equipment and skilled personnel. However, these services are commercially available.

[42]Connor, 1990.

The sediments from the Outfall 004 backwater area could potentially be dredged in the following manner. A crawler-mounted clamshell could be maneuvered to the toe of the CMSD. This equipment would dredge the sediments from the Outfall 004 backwater area and place them on top of the CMSD for drying and solidification. Once situated on top of the CMSD, earthmoving equipment could be utilized to solidify the sediments with lime and flyash. Treatability studies would be performed to determine the proper mixing ratio of sediments with binding agent for solidification.

As discussed in Section 6.5.3.2, the ground-water extraction system at the site has operated reliably since installation of the Ormet Ranney well and the interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

Pilot studies have demonstrated that treatment of the ground-water extracted by the existing interceptor wells requires careful process control[43]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation. Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

There are no operability considerations associated with the dual barrier cap components of Remedial Alternative 4. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

[43]Baker/TSA, Inc., 1990.

6.5.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 4 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements of Remedial Alternative 4 could be managed as operable units:

- ground-water extraction and treatment;
- seep collection and treatment; and
- solidification and containment measures.

Several of these component remedial measures must be implemented sequentially. For example, excavation of the carbon run-off and deposition area must be performed prior to capping of the CMSD because the carbonaceous materials would be contained in the CMSD. Similarly, excavation of the carbon run-off and deposition area must be performed prior to dredging in the Outfall 004 backwater area because the outfall drainage ditch would be rerouted through the carbon run-off and deposition area.

6.5.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 4 would be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water extraction system continues to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Periodic ground-water quality data will also provide the best means of adjusting projections of the time required to achieve reductions in contaminant concentrations.

Cap inspections would be performed to monitor the integrity of the cap barrier. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding, and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized to effectively monitor the chemical composition and concentrations of the discharges.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The former spent potliner storage area, CMSD, and CRDA would not pose a problem, since these areas would be contained with no treatment. Additional remedial actions for ground-water and the seeps would require modifications to the treatment systems. Changes of this nature would be difficult to implement. Sediments would be dredged for consolidation within the CMSD and stabilized, which would result in increased volume. This is similar for the former disposal pond solids, which will also be solidified prior to capping. Thus, further remedial action on these areas would be difficult.

6.5.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 4. Approvals would be required for construction of the ground-water treatment system for the interceptor well water that is included in this remedial alternative. Approval to construct this system would be in the form of a PTI. Similarly, a PTI may be required for the CMSD seep collection and treatment system, and the ballfield seep collection system.

Approvals would also be required for discharges to surface-water under the NPDES program, and for bank improvements along the toe of the CMSD. The NPDES permit for the Ormet facility will govern discharges to surface water under this remedial alternative.

Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.5.6.5 Availability of Off-Site Services and Capacity

Under Remedial Alternative 4, off-site transportation and disposal services would be required for most of the treatment residuals identified in Section 6.5.5.4. Off-site transportation and disposal services would not be required for the solidification residuals because these materials would be contained on-site under Remedial Alternative 4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these residuals exist within USEPA Region V[44]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. Due to the potential presence of PCBs in the oil, it has been assumed that the oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[45]. Adequate disposal capacity is commercially available.

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[44]USEPA, et. al., 1990.

[45]USEPA, et. al., 1990.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 4. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

6.5.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

Specialized equipment and skilled workers would be required for solidification of the pond solids and the sediments. This service is commercially available.

Specialized equipment and skilled workers would be required for installation of the dual barrier caps under this remedial alternative. Specialized welding equipment and qualified operators would be required for installation of the synthetic membrane barrier layer. Specialized equipment would also be required for installation of concrete revetments along the CMSD. However, the required materials and services are available through a variety of commercial sources.

Installation of steel sheet piling as an operational control during dredging of the Outfall 004 backwater area would require specialized equipment. Pile driving equipment and the required personnel are available for both land-driven and barge-driven installations.

6.5.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 4 are presented in this Section.

6.5.7.1 Capital Cost

The capital costs for Remedial Alternative 4 are summarized in Table 6-18. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Sitewide Institutional Controls
- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3

Table 6-18. Summary of Capital Costs for Sitewide Remedial Alternative 4.

COST ELEMENT	REFERENCE TABLE	ESTIMATED COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment	6-4	$1,823,000
3. Seep Collection and Treatment System	6-7	$69,550
4. Consolidation	6-15	$108,807
5. Sediment Dredging	6-16	$224,000
6. Containment	6-19	$6,286,896
7. Solidification	6-20	$7,924,380
	SUBTOTAL	$16,517,641
Engineering/Design (10%)		$1,651,764
Installation/Shakedown (5%)		$94,628
	SUBTOTAL	$18,264,033
Contingency (20%)		$3,652,807
	SUBTOTAL	$21,916,840
Ground-Water Treatment O&M (years 1-10) {1}	6-10	$5,072,115
	TOTAL	$26,988,955
	ROUND	$27,000,000

{1} Represents 10-year Present Worth Factor at 10%

- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3
- Table 6-6: Unit Costs Utilized for Estimating Containment Costs
- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System
- Table 6-19: Estimated Capital Costs for Containment Under Remedial Alternative 4
- Table 6-20: Estimated Capital Cost for Solidification Under Remedial Measures FDP-3 and FDP-7
- Table 6-16: Estimated Capital Costs For Sediment Dredging And Solidification Under Remedial Measure SED-8

6.5.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 4 are summarized in Table 6-21. The O&M costs for the ground-water extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M costs associated with the containment components of Remedial Alternative 4 are presented in Table 6-12.

TABLE 6-19. Estimated Capital Costs For Containment Under Remedial Alternative 4.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. DUAL BARRIER CAP (CMSD)				
Grading	90,000	CY	$8.23	$740,700
Membrane (40 mil HDPE)	270,000	SF	$0.50	$135,000
Geonet	270,000	SF	$0.26	$70,200
Geotextile (10 oz.)	270,000	SF	$0.18	$48,600
Fill (Placement)	6,500	CY	$2.08	$13,520
Clay (Transport)	20,000	CY	$19.00	$380,000
Clay (Placement)	20,000	CY	$2.08	$41,600
Concrete Revetments	95,000	SF	$4.00	$380,000
Hydroseeding	270,000	CY	$0.04	$10,800
			SUBTOTAL	$1,820,420
2. DUAL BARRIER CAPS (FDPs)				
Regrading	74,000	CY	$8.23	$609,020
Membrane (40 mil HDPE)	818,000	SF	$0.50	$409,000
Geonet	818,000	SF	$0.26	$212,680
Geotextile (10 oz.)	818,000	SF	$0.18	$147,240
Clay (Transport)	60,600	CY	$19.00	$1,151,400
Clay (Placement)	60,600	CY	$2.08	$126,048
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$2,688,108
3. DUAL BARRIER CAP (FSPSA)				
Fill (Transport)	16,300	CY	$11.36	$185,168
Fill (Placement)	22,500	CY	$2.08	$46,800
Membrane (40 mil HDPE)	610,000	SF	$0.50	$305,000
Geonet	610,000	SF	$0.26	$158,600
Geotextile (10 oz.)	610,000	SF	$0.18	$109,800
Clay (Transport)	45,000	CY	$19.00	$855,000
Clay (Placement)	45,000	CY	$2.08	$93,600
Hydroseed	610,000	SF	$0.04	$24,400
			SUBTOTAL	$1,778,368
			TOTAL {1}	$6,286,896
			ROUND	$6,300,000

{1} Indirect capital costs and contingencies for the containment systems are included in the summary for overall remedial alternatives.

TABLE 6-20. Estimated Capital Costs for Solidification Under Remedial Measure FDP-3, FDP-7, and FDP-10.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. FLYASH TRANSPORT	210,000	CY	$6.00	$1,260,000
2. FLYASH HANDLING	210,000	CY	$3.10	$651,000
3. LIME TRANSPORT	47,000	T	$60.00	$2,820,000
4. LIME HANDLING	42,000	CY	$3.10	$130,200
5. MIXING LIME/ASH/SOLIDS	677,000	CY	$2.46	$1,665,420
6. PLACEMENT OF SOLIDIFIED MATERIAL	672,000	CY	$2.08	$1,397,760
			TOTAL {1}	$7,924,380
			ROUND	$7,900,000

{1} Indirect capital costs and contingencies for the solidification are included in the summary for overall remedial alternatives.

TABLE 6-21. Summary of O&M Costs for Sitewide Remedial Alternative 4.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
	SUBTOTAL	$961,570
Administration (12%)		$115,388
	SUBTOTAL	$1,076,958
Contingency (20%)		$215,392
	TOTAL	**$1,292,350**
	ROUND	**$1,300,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
30 Year Operation with Ground-Water Treatment O&M for Years 1-10 Included in Capital Cost of Alternative.	$5,400,000

6.5.7.3 Present Worth

The present worth of Remedial Alternative 4 was calculated to be $32,400,000. This value was calculated in accordance with USEPA guidance[46] utilizing an operating period of 30 years and a discount rate of 10 percent.

6.6 Remedial Alternative 5

Remedial Alternative 5 constitutes a containment and off-site disposal alternative for the Ormet site. This Alternative was assembled by combining the following remedial measures:

- GW-3: Pumping of the Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;
- SP-4: Collection of Ballfield and CMSD Seeps Using Trench Drains, Treatment of CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-9: Partial Excavation with Off-Site Landfilling of the Excavated Soils, and Containment by Single Barrier Synthetic Cap;
- FDP-5: Containment by Single Barrier Synthetic Cap;
- CMSD-4: Recontouring and Containment by Single Barrier Synthetic Cap;
- CRDA-3: Excavation, Consolidation and Containment; and
- SED-8: Partial Dredging, Treatment by Solidification, Consolidation with CMSD, and Containment.

[46]USEPA, 1987.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.6.

6.6.1 Compliance with ARARs

The ability of Remedial Alternative 5 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.6.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat ground water pumped from the existing interceptor wells prior to discharge. Specifically, effluent from the lime/ferrous salt precipitation treatment system would comply with NPDES effluent limitations currently proposed for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale studies of by this technology. Fluoride concentration reductions were also achieved in the pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

This remedial alternative could achieve chemical-specific ARARs for aquifer quality. Partial excavation and containment of the former spent potliner storage area, containment of the former disposal ponds, and ground-water extraction by the existing interceptor wells could eventually achieve MCLs and MCLGs in the alluvial aquifer.

Remedial Alternative 5 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and consolidated within the CMSD prior to capping of the CMSD. The carbonaceous material in the CRDA is not itself a hazardous waste, therefore, it would not be subject to LDRs as ARARs. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Carbonaceous material identical to that present in the CRDA is routinely sampled to determine whether it exhibits characteristics which would qualify it as a RCRA characteristic waste. This material has never exhibited hazardous characteristics.

6.6.1.2 Location-Specific ARARs

Remedial Alternative 5 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid wastes in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[47]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive

[47]USEPA, 1988d.

requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

6.6.1.3 Action-Specific ARARs

Operation of the Ormet Ranney well and the existing interceptor wells would be subject to certain action-specific ARARs under Remedial Alternative 5. Specific maintenance requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 5 would comply with these requirements.

Ground-water treatment under Remedial Alternative 5 would also be subject to action-specific ARARs. This remedial alternative would comply with any Permit-to-Install requirements, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Off-site landfilling of the ground-water treatment residuals and the excavated soil from the former spent potliner storage area would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 5 would comply with these requirements. Additionally, this remedial alternative would be subject to action-specific ARARs regarding transportation and disposal of the excavated soil from the former spent potliner storage area. Remedial Alternative 5 would comply with transportation and disposal ARARs for excavated soil. Depending upon the outcome of the waste characterization, this alternative may also be subject to action-specific ARARs for transportation and disposal of the ground-water treatment residuals.

The single barrier synthetic caps that would be constructed over the former disposal ponds, the former spent potliner storage area, and the CMSD would attain or exceed the State of Ohio Solid Waste ARARs. As provided in OAC-3745-27-11(G)(1), the cap designs illustrated in Section 5 would include materials of construction that are comparable to those identified under OAC 3745-27-08 and 3745-27-11.

Capping the CMSD under this remedial alternative would not necessitate explosive gas monitoring because construction materials are generally not putrescible. Wooden scrap that was emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. Air monitoring performed during test pit excavation in the CMSD did not detect the presence of explosive gases.

Containment measures for the sediments in the Outfall 004 backwater area under this alternative may not attain TBC-based clean-up goals regarding PCBs depending upon the concentrations of PCBs in the sediments removed from the backwater area. The cleanup goals for PCBs and PAHs that are identified in Appendix F would not be attained by the partial dredging of the backwater area. Under this alternative, sediments containing greater than 25 mg/kg PCBs and greater than 370 mg/kg total PAHs would be excavated from the backwater area. The excavated materials from the backwater area would be treated and contained in the CMSD under a single barrier cap. If concentrations of PCBs in the dredged sediments exceed 50 mg/kg, a TSCA-complaint cell may need to be constructed within the CMSD. Following removal, the excavated area would be sampled to confirm that the cleanup goals for PCBs and PAHs under this alternative have been achieved.

6.6.2 Overall Protection

The protectiveness of Remedial Alternative 5 for human health and the environment would be very similar to Remedial Alternatives 3 and 4. The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;
- ingestion of contaminated media from all areas of concern;
- direct contact with contaminated media from all areas of concern;

These exposure pathways would be effectively addressed under Remedial Alternative 5 for all areas.

6.6.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 5 is described in the following sections.

6.6.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 5 could be achievable within two to four years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the existing interceptor wells represents current conditions. Effective treatment of the extracted ground water from the interceptor wells would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 5 includes 19 months for engineering design and construction following issuance of a permit to install.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the CMSD seeps could be potentially completed within 1 to 2 years. Furthermore, it is possible that the seeps would eventually disappear with the capping of the CMSD. Excavation of up to 4,000 CY of soils from the former spent potliner storage area could be implemented in 1 to 2 years.

Administrative requirements governing permitting of dredging activities under this remedial alternative would extend the timeframe for achieving protection. The extent of this increase in the time required for implementation is not known, but may be on the order of one to three years.

Remedial Alternative 5 involves several containment structures, including single barrier synthetic caps, steel sheet piling, and concrete revetments. These structures could be constructed within 2 to 3 years. The estimated construction time for capping was developed assuming sequential capping of the former spent potliner storage area, the former disposal ponds, and the CMSD.

6.6.3.2 Short-Term Reliability

Remedial Alternative 5 would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1958) and the existing interceptor wells (installed in 1972). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.6.3.1, approximately 19 months (after issuance of a permit to install) will be required for construction of the treatment system under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the ground-water treatment component of this alternative is addressed in Section 6.6.4.3.

Containment of the former spent potliner storage area, the former disposal ponds, and the CMSD would not be performed in the short-term. As discussed in Section 6.6.3.1, approximately 2 to 3 years will be required for containment of these areas. Therefore, containment of these areas would be initiated in the mid-term, and would continue over the long-term. The reliability of this component of Remedial Alternative 5 is addressed in Section 6.6.4.3.

6.6.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The containment components of Remedial Alternative 5 will require excavation and regrading of the former spent potliner storage area, regrading of the CMSD and the former disposal ponds. Additionally, the sediments in the Outfall 004 backwater area would be dredged and the carbonaceous materials in the CRDA would be excavated and placed under the cap in the CMSD. These earthmoving activities could potentially result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the ground water extracted by the interceptor wells demonstrated that this water is not acutely toxic to aquatic organisms.

There is no possibility that implementation of this alternative would generate toxic gases. Ground-water treatment would be performed at alkaline pH, therefore, the generation of HCN gas is not possible. None of the other treatment or containment components of this alternative would result in the possible generation of toxic reaction by-products.

6.6.3.4 Worker Protection

Implementation of Remedial Alternative 5 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under

this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the FSPSA and CRDA to restrict fugitive dust emissions. Partial dredging of the Outfall 004 backwater sediments is not expected to generate significant dust unless the sediments are allowed to dry, at which point dust suppressants may also be used on the sediments. Given the large amount of excavation activity, the possibility for fugitive dust generation is high. However, because dust suppressants would be utilized the amount of dust possibly generated cannot be estimated, but inhalation exposure during the periods of excavation and transfer are expected to be minimal. Appropriate protective equipment would be utilized during the period of excavation and material handling to provide additional protection of the workers.

6.6.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and
- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppresants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

6.6.4 Long-Term Effectiveness

This remedial alternative would also be protective of human health and the environment over the long-term. The long-term effectiveness that would result from implementation of Remedial Alternative 5 is evaluated in the following sections.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative consists of pumping of the Ormet Ranney well and existing interceptor wells to control and recover the plume, followed by treatment of the ground water extracted by the existing interceptor wells using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in ground water in that portion of the alluival aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years under current conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations is provided in Appendix K.

Installation of the single barrier synthetic caps as source control measures under Remedial Alternative 5 is expected to decrease this time frame, as infiltration of precipitation through the unsaturated soils would be virtually eliminated. However, due to fluctuations in the water table elevation over time and the consequent contact of ground water with unflushed soils, the extent to which aquifer restoration times may be reduced by the caps is uncertain.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the single barrier caps would promote run-off and evapotranspiration. Infiltration modelling was performed for the single barrier caps (see Appendices I and J). For the FSPSA, regrading and construction of the single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to approximately a 99.5 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to a 99.4 percent reduction over existing conditions. Based on these results, leachate generation in these areas would be virtually eliminated.

6.6.4.1 Reduction of Assumed Existing Risks

Similar to Remedial Alternative 2, implementation of Remedial Alternative 5 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the soils would be eliminated by the construction of the single barrier cap. Direct contact with the affected media beneath the caps would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted media beneath the single barrier cap, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the interceptor wells and treatment of the captured ground water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the single barrier cap.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Partial dredging of the Outfall 004 backwater area to remove constituents, followed by placement of concrete revetments over the remaining sediments would prevent direct exposure to constituents in sediments and prevent future releases from the backwater area to the river. Concrete revetments would prevent erosion and block direct exposure to the dried sediments that would remain in this area. Human exposure to the sediments beneath the revetments would be precluded because of the size and weight of the revetments. The human exposure pathways to the backwater sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would also be eliminated. Therefore, the risk to humans associated with ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater area is dredged and contained with the concrete revetments, and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over time as the sediments are covered by background river sediments. Constituents in the 004 backwater would be removed or contained beneath the concrete revetments, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.6.4.2 Magnitude of Future Risks

Similar to Remedial Alternative 2, constituents in the alluvial ground water would be collected and treated under Remedial Alternative 5. Future hypothetical exposure of plant workers, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated ground water as a source of potable water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3, reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and CMSD. Future exposure of child or adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential for exposure to any constituents that might still leach from the underlying media after the single barrier cap is installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

Single barrier synthetic caps on the former spent potliner storage area, the former disposal ponds, and the CMSD (with the consolidated carbonaceous material from the carbon run-off and deposition area) would prevent the emission of fugitive dust and eliminate direct contact exposure to the impacted soils. The single barrier caps over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. With the exception of deep burrowing animals, the single barrier caps would preclude exposure of most terrestrial organisms. It is possible that the affected media may also act as a deterrent to burrowing animal activity. The single barrier cap forms a physical barrier that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the maintenance of the single barrier cap would include control of burrowing animals through baiting and removal of seedling trees that might take root at the site. Infiltration through the single barrier cap could mobilize some of the constituents in the subsurface soils, however, as discussed in the preceding paragraph, these constituents would pose zero risks to humans or wildlife.

Because the 004 backwater area is an embayment of the Ohio River, relocation of the 004 outfall stream prior to sediment removal and placement of revetments would not eliminate benthic habitat. Sediment removal and placement of revetments would temporarily disrupt the benthic habitat in the backwater area. However, because the backwater area is an embayment, resedimentation and the associated restoration of benthic habitat would occur relatively rapidly. Studies performed by the U.S. Army Corps of Engineers (1991) indicate that in-situ capping can be an effective method of providing long-term isolation of contaminated sediments. The overall effect of these actions would be that exposure to constituents in the backwater area would be eliminated or greatly reduced. Food chain exposures associated with the Outfall 004 backwater area would be eliminated concurrently with elimination of the area as a freshwater habitat. Partial dredging of the Outfall 004 backwater area and placement of concrete revetments would essentially eliminate the potential for future releases to the Ohio River, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments.

Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases.

In summary, the remedial measures that comprise Remedial Alternative 5 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.6.4.3 Long-Term Reliability

Remedial Alternative 5 would be reliable over the long-term. As discussed in Section 6.6.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the existing interceptor wells has performed reliably since installation of these wells. In consideration of the in-line redundancy in the ground-water extraction system, ground-water containment over the long-term is expected to be highly reliable.

Long-term reliability of single barrier caps utilizing synthetic membrane materials of construction has been proven, dependent upon adequate post-closure maintenance. The relative life expectancy of a standard (i.e., single barrier) landfill cap with normal maintenance is approximately 50 to 100 years (Versar, Inc., 1991). Caps employing synthetic materials of construction are susceptible to punctures, tears, and freezing temperatures, mainly during construction. Proper QA/QC during cap construction can greatly reduce the potential for damage to the cap. Standard engineering practice of installing geotextile fabric between the vegetated layer and drainage layer, coupled with vegetating the cover with grasses that do not have deep roots, will aid in preventing root penetration. Animals that currently live on-site would be controlled prior to capping (OAC 3745-27-11 (G)(4)). The geotextile fabric and geonet will also aid in preventing the animals from burrowing into the cap. A well-maintained vegetative cover, periodic inspections and limited site access will ensure reliable long-term performance of the single barrier caps. Synthetic membranes exhibit a high degree of resistance to chemicals and are capable of elongating up to 500 percent (National Sanitation Foundation Standard Number 54). Unless atypical settlement or depressions develop, the integrity of a synthetic membrane cap will not be comprised by settlement.

No substantial uncertainties have been identified regarding off-site land disposal of soil from the former spent potliner storage area that would require special long-term considerations.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control.[48] Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

Vendor literature indicates that materials used for concrete revetments are reliable over the long-term. The fabric envelope is immune to attack by mild acids and alkalis, organic solvents and biological organisms. The current of the river will not adversely impact the revetments. Therefore, concrete revetments would be reliable over the long-term.

CERCLA require a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required.

[48]Baker/TSA, Inc. 1990.

6.6.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney well and the interceptor wells will effectively contain the ground water plume under the Ormet site. Treatment of the ground water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce constituent concentrations in the extracted ground water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. As discussed in Section 6.6.4, regarding the remediation of ground water, restoration of ground-water quality will require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property.

The single barrier synthetic cap that would be provided over the CMSD and the former spent potliner storage area under this remedial alternative will eliminate infiltrate and transport of constituents from these areas. Excavation and off-site disposal of the soils from the former spent potliner storage area would serve to permanently eliminate potential exposures to these soils.

Pumping and treating of the alluvial ground water, capping with single barrier caps, and concrete revetments over the Outfall 004 backwater area sediments will eliminate direct contact exposure, prevent releases to the air, and can effectively eliminate infiltration and transport. Therefore, Remedial Alternative 5 will eliminate or significantly reduce future exposure to the constituents present at the Ormet site.

6.6.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Similarly, the highly durable materials utilized in concrete revetments would not be likely to require replacement over the long-term. Potential for repair of single barrier caps utilizing synthetic membrane materials of construction will be limited to periodic maintenance of the soil cover. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, control of burrowing animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the cap components.

6.6.5 Reduction of Mobility, Toxicity, and Volume

This remedial alternative would result in removal of constituents for the ground water extracted by the interceptor wells, as well as for the CMSD seeps. Volume reductions would result from implementation of Remedial Alternative 5 in the partial excavation of soils from the former spent potliner storage area. However, there would be no net volume reduction to the environment because the soil would be relocated for off-site disposal. The mobility of the various organic and inorganic constituents present in the various media at the site would not be reduced under this remedial alternative, although the containment barriers that would be provided under Remedial Alternative 5 would effectively block transport pathways.

6.6.5.1 Quantities Treated or Destroyed

Ground water extracted by the interceptor wells is one of two media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the seeps along the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately 1.3 million gallons per year. Furthermore, it is possible that the seeps would eventually disappear after capping of the CMSD.

The excavated soils from the former spent potliner storage area would not undergo treatment or destruction under Remedial Alternative 5.

6.6.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot plant operations to effluent concentrations of 0.19 to 0.89 mg/L[49]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced to 10 to 15 mg/L[50]. This corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

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[49]Baker/TSA, Inc., 1990.

[50]Baker/TSA, Inc., 1990.

Under this remedial alternative, oils present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

In utilizing a single barrier cap over the CMSD coupled with regrading, infiltration would be reduced thus eliminating or significantly decreasing generation of the seeps. Following capping, the seeps may stop discharging entirely.

6.6.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the sludge would be removed from the system and disposed off-site. Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

6.6.5.4 Treatment Residuals

Treatment residuals resulting from the precipitation process consist of dewatered sludge. Baker/TSA, Inc. estimated that full scale operation would yield approximately three tons per day of dewatered sludge (filter cake) containing approximately 63 percent moisture, 250 mg/kg total cyanide, and 33,000 mg/kg iron[51]. Samples of the sludge from the pilot plant were collected

[51]Baker/TSA, Inc., 1990.

and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[52].

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the adsorber vessels. The amount of free-phase oil observed on the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5, it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

Solidification of the sediments from Outfall 004 backwater area will also generate treatment residuals. The solidified material will increase from 25 to 75 percent by volume, resulting in approximately 1,300 to 1,800 CY (Table 6-13).

6.6.6 Implementability

Remedial Alternative 5 is potentially implementable within site conditions.

6.6.6.1 Constructability and Operability

This remedial alternative is both constructable and operable within site conditions. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance, and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet

[52]Baker/TSA, Inc., 1990.

Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by any of the existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps.

As discussed in Section 6.6.3.2, the ground-water extraction system has operated reliably since installation of the Ormet Ranney well and the existing interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

Pilot studies have demonstrated that treatment of the ground water extracted by the interceptor wells requires careful process control[53]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation. Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

Commonly available earthmoving equipment, such as hydraulic excavators, would be used for the excavation of the soils from the former spent potliner storage area. Hydraulic excavators would be preferred for excavation of the 4,000 CY of soil because of the precision of this equipment in excavating soil. Off-site transportation of the excavated soil would be achieved by truck. The former spent potliner storage area's proximity to the plant access road would make this means of transportation a viable option.

[53]Baker/TSA, Inc., 1990.

The sediments from the Outfall 004 backwater area could potentially be dredged in the following manner. A crawler-mounted clamshell could be maneuvered to the toe of the CMSD. This equipment would dredge the sediments from the Outfall 004 backwater area and place them on top of the CMSD for drying and solidification. Once situated on top of the CMSD, earthmoving equipment could be utilized to solidify the sediments with lime and flyash. Treatability studies would be performed to determine the proper mixing ratio of sediments with binding agent for solidification.

Construction of single barrier caps utilizing synthetic membrane as the barrier layer would require specialized equipment for welding the seams of the membrane. This equipment would be utilized under the supervision of a qualified specialty installer. Construction of single barrier synthetic caps over the former disposal ponds would not pose undue engineering difficulties under this remedial alternative. Due to the fluidity of the underlying pond solids, the use of heavy equipment would need to be limited to prevent liquefaction of the crustal layer.

There are no operability considerations associated with the containment components of Remedial Alternative 5. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

6.6.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 5 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements of Remedial Alternative 5 could be managed as operable units:

- ground-water extraction and treatment;
- seep collection and treatment; and
- containment measures.

Several of these component remedial measures must be implemented sequentially. For example, excavation of the carbon run-off and deposition area must be performed prior to capping of the CMSD because the carbonaceous materials would be contained in the CMSD. Similarly, excavation of the carbon run-off and deposition area must be performed prior to dredging and placement of concrete revetments in the Outfall 004 backwater area because the outfall drainage ditch would be rerouted through the carbon run-off and deposition area.

6.6.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 5 could be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water extraction system continues to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Periodic ground-water quality data will also provide the best means of adjusting projections of the time required to achieve reductions in contaminant concentrations.

Cap inspections would be performed to monitor the integrity of the cap barrier. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized effectively to monitor the chemical composition and concentrations of the discharges.

Periodic inspections of the concrete revetments would be performed to ensure that no shifting or cracking of the revetment has occurred. No sediment sampling will be performed.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The former spent potliner storage area, CMSD and CRDA would not pose a problem, since these areas would be contained with no treatment. Additional remedial actions for ground water and the seeps would require modifications to the treatment systems. Changes of this nature would be difficult to implement. Sediments would be dredged for consolidation within the CMSD and stabilized, which would result in increased volume. Thus, further remedial action on the sediments would be difficult.

6.6.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 5. Approvals would be required for construction of the ground-water treatment system for the interceptor well water that is included in this remedial alternative. Approval to construct this system would be in the form of a Permit-to-Install. Similarly, a PTI may be required for the CMSD seep collection and treatment system, and the ballfield seep collection system. Approvals would also be required for discharges to surface-water under the NPDES program. The NPDES permit for the Ormet facility will govern discharge to surface water under this remedial alternative. Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.6.6.5 Availability of Off-Site Services and Capacity

Off-site transportation and disposal services would be required for a maximum of 4,000 CY of soil from the former spent potliner storage area and the treatment residuals discussed in Section 6.6.5.4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these soils and residuals exist within USEPA Region V[54]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. Due to the potential presence of PCBs in the oil, it has been assumed that the oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[55]. Adequate disposal capacity is commercially available.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 5. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial carbon suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

6.6.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

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[54]USEPA, et. al., 1990.

[55]USEPA, et. al., 1990.

Commonly available earthmoving equipment would be required for the partial excavation of soils from the former spent potliner storage area; therefore, no specialized equipment or skilled workers would be required for these activities. Specialized equipment and skilled workers would be required for installation of the single barrier caps under this remedial alternative. However, the required materials and services are available through a variety of commercial sources.

Skilled workers would not be required for installation of concrete revetments over the sediments in the Outfall 004 backwater area. Installation of steel sheet piling as an operational control during dredging of the Outfall 004 backwater area would require specialized equipment. Pile driving equipment and the required personnel are available for both land-driven and barge-driven installations.

6.6.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 5 are presented in this Section.

6.6.7.1 Capital Cost

The capital costs for Remedial Alternative 5 are summarized in Table 6-22. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Sitewide Institutional Controls

- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3

TABLE 6-22. Summary of Capital Costs for Sitewide Remedial Alternative 5.

COST ELEMENT	REFERENCE TABLE	ESTIMATED COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment System	6-4	$1,823,000
3. Seep Collection and Treatment System	6-7	$69,550
4. Sediment Dredging	6-16	$224,000
5. Excavation and Off-Site Disposal	6-23	$1,160,000
6. Containment	6-24	$4,731,402
	SUBTOTAL	$8,088,960
Engineering/Design (10%)		$808,896
Installation/Shakedown (5%)		$94,628
	SUBTOTAL	$8,992,484
Contingency (20%)		$1,798,497
	SUBTOTAL	$10,790,981
Ground-Water Treatment O&M (years 1-10) {1}	6-10	$5,072,115
	TOTAL	**$15,863,096**
	ROUND	**$16,000,000**

{1} Reflects 10-Year Present Worth Factor at 10%.

- Table 6-6: Unit Costs Utilized for Estimating Containment Costs

- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System

- Table 6-23: Estimated Capital Cost for Excavation and Off-Site Disposal Under Remedial Measure FSPSA-9

- Table 6-24: Estimated Capital Costs for Containment Under Remedial Alternative 5

6.6.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 5 are summarized in Table 6-25. The O&M costs for the ground-water extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M costs associated with the containment components of Remedial Alternative 5 are presented in Table 6-12.

6.6.7.3 Present Worth

The present worth of Remedial Alternative 5 was calculated to be $21,400,000. This value was calculated in accordance with USEPA guidance[56] utilizing an operating period of 30 years and a discount rate of 10 percent.

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[56]USEPA, 1987.

TABLE 6-23. Estimated Capital Cost for Excavation and Off-Site Disposal Under Remedial Measure FSPSA-9.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. FSPSA HOTSPOT				
Excavation	4,025	CY	$6.15	$24,754
Transportation	210	load	$740	$155,400
Disposal	4,025	CY	$230	$925,750
Fill (Transport)	4,025	CY	$11.36	$45,724
Fill (Placement)	4,025	CY	$2.08	$8,372
			TOTAL {1}	$1,160,000
			ROUND	$1,200,000

{1} Indirect capital costs and contingencies for excavation and off-site disposal are included in the summary for overall remedial alternatives.

TABLE 6-24. Estimated Capital Cost for Containment Under Remedial Alternative 5.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. CONCRETE REVETMENTS	13,500	SF	$4.00	$54,000
2. SINGLE BARRIER CAP (CMSD)				
Fill (Placement)	5,000	CY	$2.08	$10,400
Grading	90,000	CY	$8.23	$740,700
Membrane (40 mil HDPE)	270,000	SF	$0.50	$135,000
Geonet	270,000	SF	$0.26	$70,200
Geotextile (10 oz.)	540,000	SF	$0.18	$97,200
Borrow (Transport)	13,000	CY	$5.00	$65,000
Borrow (Placement)	13,000	CY	$9.82	$127,660
Rip-Rap	860	T	$31.85	$27,391
Hydroseeding	270,000	SF	$0.04	$10,800
			SUBTOTAL	$1,338,351
3. SINGLE BARRIER CAPS (FDPs)				
Fill (Transport)	21,700	CY	$17.04	$369,768
Fill (Placement)	43,750	CY	$2.08	$91,000
Membrane (40 mil HDPE)	818,000	SF	$0.50	$409,000
Geonet	818,000	SF	$0.26	$212,680
Geotextile (10 oz.)	818,000	SF	$0.18	$147,240
Borrow (Transport)	39,400	CY	$5.00	$197,000
Borrow (Placement)	39,400	CY	$9.82	$386,908
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$1,846,316
4. SINGLE BARRIER CAP (FSPSA)				
Fill (Transport)	20,300	CY	$11.36	$230,608
Fill (Placement)	26,500	CY	$2.08	$55,120
Membrane (40 mil HDPE)	610,000	SF	$0.50	$305,000
Geonet	610,000	SF	$0.26	$158,600
Geotextile (10 oz.)	1,220,000	SF	$0.18	$219,600
Borrow (Transport)	30,000	CY	$5.00	$150,000
Borrow (Placement)	30,000	CY	$9.82	$294,600
Hydroseed	610,000	SF	$0.04	$24,400
			SUBTOTAL	$1,437,928
5. CONSOLIDATE CRDA IN CMSD				
Clearing/Grubbing	4.5	acre	$2,800	$12,600
Excavation	5,700	CY	$6.15	$35,055
Borrow (Transport)	3,600	CY	$5.00	$18,000
Borrow (Placement)	3,600	CY	$9.82	$35,352
Hydroseeding	195,000	SF	$0.04	$7,800
			SUBTOTAL	$108,807
			TOTAL {1}	$4,731,402
			ROUND	$4,700,000

{1} Indirect capital costs and contingencies for the containment systems are included in the summary for overall remedial alternatives.

TABLE 6-25. Summary of O&M Costs for Sitewide Remedial Alternative 5.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
	SUBTOTAL	$961,570
Administration (12%)		$115,388
	SUBTOTAL	$1,076,958
Contingency (20%)		$215,392
	TOTAL	**$1,292,350**
	ROUND	**$1,300,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR) 30 Year Operation with Ground-Water Treatment O&M for Years 1-10 Included in Capital Cost of Alternative.	$5,400,000

6.7 Remedial Alternative 6

Remedial Alternative 6 constitutes a treatment and containment alternative for the Ormet site. This alternative was assembled by combining the following remedial measures

- GW-3: Pumping of Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;
- SP-4: Collection of the Ballfield and CMSD Seeps Using Trench Drains, Treatment of CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-9: Partial Excavation with Off-site Landfilling of the Excavated Soils, and Containment by Single Barrier Synthetic Cap;
- FDP-3: Treatment by Stabilization and Vegetated Soil Cover;
- CMSD-7: Complete Excavation, Treatment by Thermal Oxidation, and Containment by Single Barrier Synthetic Cap;
- CRDA-5: Excavation and Treatment by Thermal Oxidation; and
- SED-7: Complete Dredging, Solidification, and Consolidation.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.7.

6.7.1 Compliance with ARARs

The ability of Remedial Alternative 6 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.7.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat ground water pumped by the existing interceptor wells prior to discharge to the Ohio River. Specifically, effluent from the lime/ferrous salt precipitation treatment system would comply with NPDES effluent limitations currently proposed for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale demonstration of this technology. Fluoride concentration reductions were also achieved in the pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

This remedial alternative could achieve chemical-specific ARARs for aquifer quality. Partial excavation and containment of the former spent potliner storage area and the former disposal ponds, coupled with ground-water extraction could eventually achieve MCLs and MCLGs in the alluvial aquifer.

Remedial Alternative 6 would also be subject to various relevant and appropriate chemical-specific requirements. Thermal treatment of the materials contained within the CMSD and the carbonaceous material from the carbon run-off and deposition area would be subject to the following requirements:

- OAC 3745-17-02(A,B,C): Establishes specific standards for total suspended particulate emissions.

- OAC 3745-17-05: Sets forth the non-degradation policy for particulate.

- OAC 3745-17-07(A-D): Specifies the allowable opacity for visible particulate emission.

- OAC 3745-17-09(A,B,C): Establishes particulate emission limitations and odor restrictions for incinerators.

- OAC 3745-18-06(A-G): Establishes limitations for sulfur dioxide emissions.

- OAC 3745-21-08(A-E): Establishes requirements for minimization of carbon monoxide emissions from stationary sources.

Remedial Alternative 6 would comply with these requirements.

Remedial Alternative 6 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. The carbonaceous material in the CRDA is not itself a hazardous waste, therefore, it would not be subject to LDRs as ARARs. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Carbonaceous material identical to that present in the CRDA is routinely sampled to determine whether it exhibits characteristics which would qualify it as a RCRA characteristic waste. This material has never exhibited hazardous characteristics.

6.7.1.2 Location-Specific ARARs

Remedial Alternative 6 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid wastes in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[57]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD

[57]USEPA, 1988d.

sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

Remedial Alternative 6 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and treated by thermal oxidation.

6.7.1.3 Action-Specific ARARs

Operation of the Ormet Ranney well and the existing interceptor wells would also be subject to certain action-specific ARARs under Remedial Alternative 6. Specific maintenance requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 6 would comply with these requirements.

Ground-water treatment under Remedial Alternative 6 would also be subject to action-specific ARARs. This remedial alternative would comply with any Permit-to-Install requirements, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Off-site landfilling of the excavated soils from the area of greater relative concentration in the former spent potliner storage area, and ground-water treatment residuals would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 6 would comply with these requirements. Remedial Alternative 6 would also be subject to action-specific ARARs regarding transportation and disposal for the excavated soils from the former spent potliner storage area. Remedial Alternative 6 would comply with these transportation and disposal requirements. Depending on the outcome of the waste characterization, Remedial Alternative 6 may also be subject to various transportation and disposal requirements for the ground-water treatment residuals.

The single barrier caps that would be constructed over the CMSD treatment residuals and the former spent potliner storage area would attain or exceed State of Ohio Solid Waste ARARs. As provided in OAC 3745-27-11(G)(1), the cap designs illustrated in Section 5 would include materials of construction that are comparable to those identified under OAC 3745-27-08 and 3745-27-11. The soil cover over the former disposal ponds would be in general accordance with federal solid waste ARARs for the closure of areas utilized in conjunction with activities involving solid waste, and effectively addresses all risks assumed in the Baseline Risk Assessment.

The State of Ohio solid waste regulations are more stringent than the Federal Subtitle D guidelines. The soil cover specified under this alternative would not attain the State ARARs for closure of areas utilized in conjunction with activities involving solid waste.

Capping the CMSD under this remedial alternative would not necessitate explosive gas monitoring because construction materials are generally not putrescible. Wooden scrap that was emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. Air monitoring performed during test pit excavation in the CMSD did not detect the presence of explosive gases.

Remedial Alternative 6 would be subject to various relevant and appropriate action-specific requirements relating to thermal treatment of the materials in the CMSD and the carbonaceous material from the carbon run-off and deposition area. The specific design and performance standards for incineration that are relevant and appropriate under Remedial Alternative 6 are as follows:

- OAC 3745-50-44(C8): Substantive permit requirements for incineration.

- OAC 3745-50-62(A-D): Specifies trial burn requirements for incinerators.
- ORC 3734.02(I): Establishes air emission requirements for particulate matter, dust, fumes, gas, mist, smoke, vapor, and odorous substances.
- OAC 3745-15-07(A): Defines and prohibits air pollution nuisances.
- OAC 3745-16-02(B,C): Establishes allowable stack height requirements for air emission sources based on good engineering practice.
- OAC 3745-23-06: Establishes requirements for minimization of nitrogen oxide emissions from stationary sources.
- OAC 3745-23-04: Prohibits the significant and avoidable deterioration of air quality by the release of nitrogen oxide emissions.

Remedial Alternative 6 would comply with the majority of these requirements. However, thermal treatment of media containing elevated cyanide concentrations would result in emissions of nitrogen gas. Appreciable amounts of nitrogen oxides(NO_x) may exist[58]. Monroe County is in attainment for NO_x and would be covered by the NO_x non-degradation ARAR. Commercially available transportable rotary kiln incinerators are not equipped with air pollution control equipment to remove NO_x. However, air pollution control equipment could be added to the incinerator to reduce NO_x emissions. Therefore, this remedial alternative would achieve ARARs regarding NO_x non-degradation. Emission controls to achieve National Ambient Air Quality Standards and National Emission Standards for Hazardous Air Pollutants will be evaluated during

[58]Kiang and Metry, 1982.

evaluated during the RD phase of the project. The installation and operation of add-on emission control technology would increase the cost of this alternative.

Containment measures for the sediments in the Outfall 004 backwater area under this alternative may not attain TBC-based clean-up goals regarding PCBs depending upon the concentrations of PCBs in the sediment removed from the backwater area. The cleanup (TBC information) goals for PCBs and PAHs identified in Appendix F would be attained in the backwater area under this alternative through complete dredging. Under this alternative, soils containing PCBs and PAHs at concentrations greater than the SQCs (see Appendix F) would be excavated from the backwater area. Furthermore, the excavated materials from the backwater area would be treated and contained in the CMSD under a single barrier cap. If concentrations of PCBs in the dredged sediment exceed 50 mg/kg, a TSCA-complaint cell may need to be construction within the CMSD. Following removal, the excavated area would be sampled to confirm that the cleanup goals have been achieved.

6.7.2 Overall Protection

The protectiveness of Remedial Alternative 6 for human health and the environment would be very similar to Remedial Alternatives 3 through 5. The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;
- ingestion of contaminated media from all areas of concern;
- direct contact with contaminated media from all areas of concern;

These exposure pathways would be effectively addressed under Remedial Alternative 6 for all areas.

6.7.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 6 is described in the following sections.

6.7.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 6 could be achievable within 13 to 15 years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the existing interceptor wells represents current conditions. Effective treatment of the extracted ground water from the interceptor wells would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 6 includes 19 months for engineering design and construction following issuance of a permit to install.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the CMSD seeps could be potentially completed within 1 to 2 years. Furthermore, it is possible that the seeps would eventually disappear after the capping of the CMSD. Excavation of the 4,000 CY of soils from the former spent potliner storage area could be implemented in 1 to 2 years.

Processing rates for in-situ stabilization are approximately 1200 CY/8 hour day[59]. Stabilization of the pond solids and solidification of the sediments could be completed within 1 to 2 years.

Remedial Alternative 6 also involves several containment structures including dual barrier caps, and steel sheet piling. These structures could be constructed within 2 to 3 years. This timeframe is in addition to the treatment timeframe discussed above. The estimated construction time for capping was developed assuming sequential capping of the former spent potliner storage area, the former disposal ponds, and the CMSD.

Inquiries to vendors of transportable rotary kiln incinerators indicated that thermal treatment processing rates are highly variable and can range from 100 to 225 tons per day. Assuming a density of 1.5 tons per cubic yard, approximately 4 to 10 years would be required for treatment of the CMSD. The timeframe for this remedial measure would be expected to be in the upper portion of this range due to the need to pre-process the material in the CMSD prior to thermal treatment.

Administrative requirements governing permitting of dredging activities under this remedial alternative would extend the timeframe for achieving protection. The extent of this increase in the time required for implementation is not known, but may be on the order of one to three years.

[59]Cullinane, et.al, 1986.

6.7.3.2 Short-Term Reliability

Remedial Alternative would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1972) and the existing interceptor wells (installed in 1958). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.7.3.1, approximately 19 months (after issuance of a permit to install) will be required for construction of the treatment system under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the treatment component of this alternative is addressed in Section 6.7.4.3.

Thermal treatment of the materials from the CMSD and the carbon run-off and deposition area under this remedial alternative would not be performed in the short-term. As discussed in Section 6.7.3.1, thermal treatment would require approximately four to ten years for implementation under this alternative. Thermal treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the treatment component of this alternative is addressed in Section 6.7.4.3.

Stabilization of the solids in the former disposal ponds and containment of the former spent potliner storage area, the former disposal ponds, and the CMSD would not be performed in the short-term. As discussed in Section 6.7.3.1, approximately 1 to 2 years will be required for stabilization of the pond solids and solidification of the sediments. Additionally, 2 to 3 years will be required for containment of these areas. Therefore, stabilization, solidification, and containment of these areas would be initiated in the mid-term, and would continue over the long-term. The reliability of this component of Remedial Alternative 6 is addressed in Section 6.7.4.3.

6.7.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The treatment and containment components of Remedial Alternative 6 will require regrading of the CMSD, former spent potliner storage area, and the former disposal ponds and stabilization of the former disposal ponds solids and the dredged sediments. These activities could result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the Outfall 004 water, which includes untreated ground water extracted by the existing interceptor wells, demonstrated that this water is not acutely toxic to aquatic organisms.

Implementation of this remedial alternative would result in air emissions from the thermal treatment equipment. Air pollution control equipment would be added to reduce NO_x emissions. This alternative would be protective of the health and safety of the community because of the air pollution controls that would be utilized.

There is no possibility that implementation of this alternative would generate toxic gases. Ground-water treatment would be performed at alkaline pH, therefore, the generation of HCN gas is not possible. None of the other treatment or containment components of this alternative would result in the possible generation of toxic reaction by-products.

6.7.3.4 Worker Protection

Implementation of Remedial Alternative 6 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the FSPSA, CMSD, and CRDA to restrict fugitive dust emissions. Dredging of the Outfall 004 backwater sediments is not expected to generate significant dust unless the sediments are allowed to dry, at which point dust suppressants may also be used on the sediments. Given the large amount of excavation activity, the possibility for fugitive dust generation is high. However,because dust suppressants would be utilized the amount of dust possibly generated cannot be estimated, but inhalation exposure during the periods of excavation and transfer are expected to be minimal. Appropriate protective equipment would be used during the period of excavation and material handling to provide additional protection of the workers.

6.7.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and
- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppresants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

6.7.4 Long-Term Effectiveness

This remedial alternative would be protective of human health and the environment over the long-term.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative includes ground-water remedial measure GW-3, which consist of pumping to control and recover the plume, followed by treatment of the ground water extracted by the interceptor wells using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in ground water in that portion of the alluvial aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years under current site conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations is provided in Appendix K. Installation of the single barrier synthetic caps as source control measures under Remedial Alternative 6 is expected to decrease this time frame, as infiltration of precipitation through the unsaturated soils would be virtually eliminated. However, due to fluctuations in the water table elevation over time and the consequent contact of ground water with unflushed deposits, the extent to which aquifer restoration times may be reduced by the caps is uncertain.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the single barrier caps would promote run-off and evapotranspiration. Infiltration modelling was performed for the single barrier caps (see Appendices I and J). For the FSPSA, regrading and construction of the single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to approximately a 99.5 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to a 99.4 percent reduction over existing conditions. This alternative would be effective in reducing the infiltration of precipitation through the soils in the former disposal ponds. Regrading of the site and construction of the vegetated soil covers over the FDPs would promote run-off and evapotranspiration. Based on these results, leachate generation in these areas would be virtually eliminated.

6.7.4.1 Reduction of Assumed Existing Risks

Similar to Remedial Alternative 2, implementation of Remedial Alternative 6 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the affected media would be eliminated by the construction of the single barrier cap and vegetated soil cover. Direct contact with the media beneath the cap or cover would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted soils beneath the single barrier cap or vegetated soil cover, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the interceptor wells and treatment of the captured ground-water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the single barrier cap and vegetated soil cover.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Dredging of the Outfall 004 backwater area to remove constituents, followed by containment in the CMSD would prevent direct exposure to constituents in sediments and prevent future releases from the backwater area to the river. The human exposure pathways to the backwater sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would be eliminated. Therefore, the risk to humans associated with ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater area is dredged and contained within the CMSD, and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over time as the sediments are covered by background river sediments. Constituents in the Outfall 004 backwater would be removed and contained within the CMSD, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.7.4.2 Magnitude of Future Risks

Similar to Remedial Alternative 2, constituents in the alluvial ground water would be collected and treated under Remedial Alternative 6. Future hypothetical exposure of plant workers, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated ground water as a source of potable water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3, reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and the CMSD. Future exposure of child and adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential for exposure to any constituents that might still leach from the underlying media after the dual barrier caps are installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

The caps and soil covers on the former spent potliner storage area, the former disposal ponds, and the CMSD (with the consolidated carbonaceous material from the carbon run-off and deposition area and the dredged sediments) would prevent the emission of fugitive dust and eliminate direct contact exposure to the impacted media. The single barrier cap and vegetated soil cover over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. The single barrier cap and vegetated soil cover form a physical barrier that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the routine maintenance of the single barrier cap and vegetated soil cover would include control of burrowing animals through baiting and removal of seedling trees that might take root at the site. Infiltration through the single barrier cap or vegetated soil cover could mobilize some of the constituents in the subsurface soils, however, as discussed in the preceding paragraph, these constituents would pose zero risks to humans or wildlife.

Because the 004 backwater area is an embayment of the Ohio River, relocation of the 004 outfall stream prior to sediment removal would not eliminate benthic habitat. Dredging of the sediments would temporarily disrupt the benthic habitat in the backwater area. However, because the backwater area is an embayment, resedimentation and the associated restoration of benthic habitat would occur relatively rapidly. The overall effect of these actions would be that exposure to constituents in the backwater area would be eliminated.

Food chain exposures associated with the Outfall 004 backwater area would be also eliminated. Dredging of the Outfall 004 backwater area would eliminate the potential for future releases to the Ohio River, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments. Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases.

In summary, the remedial measures that comprise Remedial Alternative 6 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.7.4.3 Long-Term Reliability

Remedial Alternative 6 would be reliable over the long-term. As discussed in Section 6.7.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the existing interceptor wells has performed reliably since installation of these wells. In consideration of the in-line redundancy in the ground-water extraction system, ground-water containment over the long-term is expected to be highly reliable.

Stabilized materials are subject to breakdown due to natural weathering. Sulfate-rich ground water can cause swelling and disintegration of Portland-cement/fly-ash-solidified waste, or leaching by rainwater can remove buffering materials in a stabilized waste and allow pH to drop and metals to be taken into solution in contacting water[60]. Covering the former disposal ponds with a vegetated soil layer would not significantly enhance the long-term reliability of Remedial Alternative 6.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control.[61] Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

Long-term reliability of single barrier caps utilizing synthetic membrane materials of construction has been proven, dependent upon adequate post-closure maintenance. The reliable life expectancy of a standard (i.e., single barrier) landfill cap with normal maintenance is approximately 50 to 100 years (Versar, Inc., 1991). These caps are susceptible to punctures,

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[60]Cullinane, et.al, 1986.

[61]Baker/TSA, Inc. 1990.

tears, and freezing temperatures, mainly during construction. Proper QA/QC during cap installation can greatly reduce the potential for damage to the cap. Standard engineering practice of installing geotextile fabric between the vegetated layer and drainage layer, coupled with vegetating the cover with grasses that do not have deep roots, will aid in preventing root penetration. Animals that currently live on-site would be controlled prior to capping (OAC 3745-27-11 (G)(4)). The geotextile fabric and geonet will also aid in preventing the animals from burrowing into the cap. A well-maintained vegetative cover, periodic inspections and limited site access will ensure reliable long-term performance of the single barrier caps.

No substantial uncertainties have been identified regarding off-site land disposal of soil from the former spent potliner storage area that would require special long-term considerations.

CERCLA requires a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required. Synthetic membranes exhibit a high degree of resistance to chemical contract and are capable of elongating up to 500 percent (National Sanitation Foundation Standard Number 54). Unless atypical settlement or depressions develop, the integrity of a synthetic membrane cap will not be compromised by settlement.

6.7.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney well and the interceptor wells will effectively contain the ground water plume under the Ormet site. Treatment of the ground water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce constituent concentrations in the extracted ground water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. As discussed in Section 6.7.4, regarding the remediation of ground water, restoration of ground-water quality will require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property.

The single synthetic barrier cap that would be provided over the CMSD and the former spent potliner storage area under this remedial alternative will eliminate potential infiltrate and transport of constituents from these areas. Excavation and off-site disposal of the soils from the former spent potliner storage area would serve to permanently eliminate potential exposures to these soils.

Pumping and treating of the alluvial ground water, capping with single barrier caps, and concrete revetments over the Outfall 004 backwater area sediments will eliminate direct contact exposure, prevent releases to the air, and can effectively eliminate infiltration and transport. Therefore, Remedial Alternative 6 will eliminate or significantly reduce future exposure to the constituents present at the Ormet site.

6.7.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Potential for repair of single barrier caps utilizing synthetic membranes as materials of construction will be limited to periodic maintenance of the soil cover. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, control of burrowing animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the cap components.

6.7.5 Reduction of Mobility, Toxicity, and Volume

This remedial alternative would result in removal of constituents for the ground water extracted by the interceptor wells, as well as for the CMSD seeps. Volume reductions would result from implementation of Remedial Alternative 6 in the partial excavation of soils from the former spent potliner storage area. However, there would be no net volume reduction to the environment because the soils would be relocated for off-site disposal. The mobility of the various organic and inorganic constituents present in the former disposal ponds would be reduced by stabilization; however mobility would not be reduced at the former spent potliner storage area, CMSD, or the sediments. The containment barriers that would be provided under Remedial Alternative 6 would effectively block transport pathways.

6.7.5.1 Quantities Treated or Destroyed

Ground water extracted by the interceptor wells is one of several media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

The second media that would be treated under Remedial Alternative 6 is the seep water. Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately 1.3 million gallons per year. However, it is possible that the seeps would eventually disappear after treatment and capping of the CMSD.

The solids in the former disposal ponds is the third media that would undergo treatment. Using the Pond areas stated in Table 2-2 and the isopach maps presented in Figures 4 through 7 of the RI Report, approximately 420,000 CY of pond solids will be stabilized prior to capping.

The excavated soils from the former spent potliner storage area would not undergo treatment or destruction under Remedial Alternative 6.

This remedial alternative would include treatment of approximately 228,000 CY of material from the CMSD. This quantity represents the total quantity of material in the CMSD (240,000 CY) less the quantity of bulky materials that would be sorted out prior to thermal treatment (12,000 CY). As discussed in Section 5, the sorted materials would be addressed by off-site landfilling. Excavated material from the CRDA would undergo thermal treatment along with the CMSD materials.

6.7.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot scale conditions to effluent concentrations of 0.19 to 0.89 mg/L[62]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced to 10 to 15 mg/L[63]. This corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

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[62]Baker/TSA, Inc., 1990.

[63]Baker/TSA, Inc., 1990.

Under this remedial alternative, oils present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

Stabilization of the solids from the former disposal ponds would be achieved using a pozzolanic material, such as lime or fly ash. Stabilization utilizing pozzolanic materials, has shown to be effective for metal sludges[64]. Lime and lime/flyash processes are able to accommodate large quantities of organics as well as inorganic sludges[65].

Thermal treatment of approximately 228,000 CY of material from the CMSD would yield significant concentration reductions for organics and cyanide present in the CMSD. A Destruction and Removal Efficiency (DRE) of 99.99% could be achieved for these substances using a transportable rotary kiln incinerator. Due to the presence of PCBs in the CMSD, a DRE of 99.9999% may be relevant and appropriate. Rotary kiln incinerators can potentially achieve a DRE of 99.9999%.

After thermal treatment a single barrier cap over the CMSD would be utilized, therefore, infiltration would be reduced and generation of the seeps would be eliminated or significantly decreased. Following capping, the seeps may stop discharging entirely.

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[64]USEPA, 1989i.

[65]Conner, 1990.

6.7.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the sludge would be removed from the system and disposed off-site. Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

Reduction of the pH of the stabilized material may cause the metals to be taken out of solution. Natural weathering may also cause the stabilized material to disintegrate. The vegetated soil cover will aid in preventing these from affecting the stabilized material.

Thermal destruction of the organics and cyanide present in the CMSD is an irreversible process. This component of Remedial Alternative 6 would destroy organics forming simple inorganics such as carbon dioxide and water. These substances cannot be recombined to yield the constituents present in the CMSD.

6.7.5.4 Treatment Residuals

Treatment residuals resulting from the precipitation process consist of dewatered sludge. Baker/TSA, Inc. estimated that full scale operation would yield approximately three tons per day of dewatered sludge (filter cake)[66]. Samples of the sludge from the pilot plant were collected and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[67].

[66]Baker/TSA, Inc., 1990.

[67]Baker/TSA, Inc., 1990.

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the adsorber vessels. The amount of free-phase oil observed on the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5, it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

Based on visual observations during test pit excavation in the CMSD, the material to be treated consists of fire-brick, steel, some wood and other construction and demolition debris. Due to the nature of this material, it is estimated that only minimal volume reductions (i.e., 10 to 20 percent) will occur during thermal treatment. Material to be excavated from the CRDA consists almost exclusively of carbonaceous material (i.e., spent anode comprised of calcined coke). Therefore, a volume reduction of 90 percent or greater is anticipated during the thermal treatment of the carbonaceous material excavated from the CRDA.

6.7.6 Implementability

Remedial Alternative 6 is potentially implementable within site conditions.

6.7.6.1 Constructability and Operability

This remedial alternative is operable within site conditions, but poses certain constructability problems. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by any of the existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps.

Construction of single barrier caps utilizing synthetic membranes as a barrier layer would require specialized seaming equipment and skilled personnel. The synthetic membrane barrier layer requires specialized equipment for welding the seams of the membrane panels. This equipment would be utilized under the supervision of a qualified specialty installer.

Under Remedial Alternative 6, stabilization of the solids from the former disposal ponds would be accomplished using backhoes, crawler-mounted injector-type mixers or a vertical auger mixer/injector[68]. Because of the size of Pond 5, clamshell or dragline equipment would probably be required to ensure an adequate reach for mixing the contents of Pond 5 with the stabilizing agents. Access for this type of equipment would be difficult along the berm of Pond 5 bordering the Ohio River due to the narrowness of the berm. To address the equipment access problem, Pond 5 could potentially be stabilized by working progressively from the side adjacent to the former spent potliner storage area toward the river. This progressive approach would not prohibit the use of the equipment described above. Clamshell and dragline equipment for this propose is available. The lime and fly ash reagents that would be used for stabilization under Remedial Alternative 6 are available in the Ohio River valley region. Treatability studies would be required to determine appropriate mixing ratio of the materials in the former disposal ponds with lime and fly ash for solidification. Prior to capping, the stabilized solids would be regraded to provide adequate slopes for surface water run-off.

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[68]Connor, 1990.

Commonly available earthmoving equipment, such as hydraulic excavators, would be used for the excavation of the soils from the former spent potliner storage area. Hydraulic excavators would be preferred for excavation of the 4,000 CY of soil because of the precision of this equipment in excavating soil. Off-site transportation of the excavated soil would be achieved by truck. The former spent potliner storage area's proximity to the plant access road would make this means of transportation a viable option.

As discussed in Section 6.7.3.2, the ground-water extraction system has operated reliably since installation of the Ormet Ranney well and the existing interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

The sediments from the Outfall 004 backwater area could potentially be dredged in the following manner. A crawler-mounted clamshell could be maneuvered to the toe of the CMSD. This equipment would dredge the sediments from the Outfall 004 backwater area and place them on top of the CMSD for drying and stabilization. Once situated on top of the CMSD, earthmoving equipment could be utilized to stabilize the sediments with lime and flyash.

Thermal treatment of the material in the CMSD would be difficult to implement. The large amount of material handling, sorting, and pre-processing would require a number of temporary storage pads. Sufficient space is not available in the vicinity of the CMSD for these storage pads, as well as for the thermal processing equipment, ash storage pads, ancillary equipment, and support facilities. Due to the proximity of the CMSD to the river, operational controls would be required to prevent sloughing of materials into the river during excavation activities. An ultimate analysis of the CMSD and CRDA material would be required to determine the percentage of combustible products formed from incineration. A trial burn would also be required to determine the destruction and removal efficiency.

Pilot studies have demonstrated that treatment of the ground water extracted by the interceptor wells requires careful process control[69]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation. Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

There are no operability considerations associated with the containment components of Remedial Alternative 6. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

6.7.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 6 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements of Remedial Alternative 6 could be managed as operable units:

- ground-water extraction and treatment;
- seep collection and treatment;
- stabilization; and
- containment measures.

Several of these component remedial measures must be implemented sequentially. For example, treatment of the former disposal ponds must be performed prior to excavation and treatment of the CMSD because of the mutual support provided by these areas.

[69]Baker/TSA, Inc., 1990.

6.7.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 6 could be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water operation of the Ormet Ranney well and the interceptor wells continue to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Periodic ground-water quality data will also provide the best means of adjusting projections of the time required to achieve reductions in contaminant concentrations.

Cap inspections would be performed to monitor the integrity of the cap barrier. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding, and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized effectively to monitor the chemical composition and concentrations of the discharges.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The former spent potliner storage area would not pose a problem, since this area would be contained with no treatment. The CRDA material would be excavated and treated off-site. Additional remedial actions for ground water and the seeps would require modifications to the treatment systems. Changes of this nature would be difficult to implement. Sediments would be dredged for consolidation within the CMSD and stabilized, which would result in increased volume. After stabilization, the sediments would be capped. This is similar for the former disposal pond solids, which will also be stabilized prior to capping. The CMSD materials would be thermally treated prior to capping. The residual material would be in an altered state from the original material. Thus, further remedial action on the treated sediments and CMSD waste would be difficult.

6.7.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 6. Approvals would be required for construction of the ground-water treatment system for the interceptor wells that is included in this remedial alternative. Approval to construct this system would be in the form of a Permit-to-Install. Similarly, a PTI may be required for the CMSD seep collection and treatment system, and the ballfield seep collection system.

Thermal treatment of the materials located in the CMSD will be performed entirely as an on-site response action. As such, thermal treatment will not require permitting according to the site response CERCLA Regulations. CERCLA Section 121(e) states that on-site response actions may proceed without obtaining permits or other administrative requirements. However, the thermal treatment component of this remedial alternative will require compliance with substantive requirements of action-specific ARARs for incinerators. For example, before commencing incineration, a trial burn will have to be conducted according to OAC 3745-50-62 in order to determine emissions and operating conditions for the incinerator. Approvals would also be required for discharges to surface-water under the NPDES program. The NPDES permit for the Ormet facility will govern discharges to surface water under this remedial alternative. Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.7.6.5 Availability of Off-Site Services and Capacity

Off-site transportation and disposal services would be required for a maximum of 4,000 CY of excavated soil from the former spent potliner storage area and the treatment residuals discussed in Section 6.7.5.4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these residuals exist within USEPA Region V[70]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. Due to the potential presence of PCBs in the oil, it has been assumed that the oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[71]. Adequate disposal capacity is commercially available.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 6. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

6.7.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

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[70]USEPA, et. al., 1990.

[71]USEPA, et. al., 1990.

Skilled workers would not be required for installation of concrete revetments in the Outfall 004 backwater area. Installation of steel sheet piling as an operational control during dredging of the Outfall 004 backwater area would require specialized equipment. Pile driving equipment and the required personnel are available for both land-driven and barge-driven installations.

Specialized equipment and skilled workers would be required for stabilization of the solids from the former disposal ponds. This service is commercially available.

Commonly available earthmoving equipment would be required for the partial excavation of soils from the former spent potliner storage area; therefore, no specialized equipment or skilled workers would be required for these activities. Specialized equipment would be required for thermal treatment under this remedial alternative. Transportable rotary kiln incinerators and grinding equipment necessary for implementation of this alternative are available.

Specialized equipment and skilled workers would be required for installation of the single barrier caps or the vegetated soil cover under this remedial alternative. However, the required materials and services are available through a variety of commercial sources.

6.7.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 6 are presented in this Section.

6.7.7.1 Capital Cost

The capital costs for Remedial Alternative 6 are summarized in Table 6-26. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Site-Wide Institutional Controls
- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System (Remedial Measure GW-3)
- Table 6-6: Unit Costs Utilized for Estimating Containment Costs
- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System
- Table 6-20: Estimated Capital Cost for Solidification Under Remedial Measures FDP-3 and FDP-7
- Table 6-27: Estimated Capital Costs for Complete Sediment Dredging and Solidification Under Remedial Measure SED-7
- Table 6-23: Estimated Capital Costs for Excavation and Off-Site Disposal Under Remedial Measure FSPSA-9
- Table 6-28: Estimated Capital Costs for Containment under Remedial Alternative 6
- Table 6-29: Estimated Capital Costs for Thermal Treatment Under Remedial Measure CMSD-7

TABLE 6-26. Summary of Capital Costs for Sitewide Remedial Alternative 6

COST ELEMENT	REFERENCE TABLE	ESTIMATED COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment System	6-4	$1,823,000
3. Seep Collection and Treatment System	6-7	$69,550
4. Solidification	6-20	$7,924,380
5. Excavation and Off-Site Disposal	6-23	$1,160,000
6. Containment	6-28	$2,109,603
7. Thermal Treatment	6-29	$68,532,360
8. Sediment Dredging	6-27	$270,000
9. Future Containment of CMSD (1)	6-30	$436,000
	SUBTOTAL	$82,405,901
Engineering/Design (10%)		$8,240,590
Installation/Shakedown (5%)		$3,521,245
	SUBTOTAL	$94,167,736
Contingency (20%)		$18,833,547
	SUBTOTAL	$113,001,283
Ground-Water Treatment O&M (years 1-10) {2}	6-10	$5,072,115
	TOTAL {1}	$118,073,398
	ROUND	$118,000,000

{1} Present worth discounted to year 10.

{2} Reflects 10-year present worth factor at 10%.

TABLE 6-27. Estimated Capital Costs for Complete Sediment Dredging and Solidification Under Remedial Measure SED-7.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. CONSOLIDATE SEDIMENTS IN CMSD				
Steel Sheet Piling (Temporary)	3,000	SF	$46	$138,000
Silt Curtains	1	LS	$40,000	$40,000
Dredging	2,000	CY	$33	$66,000
			SUBTOTAL	$244,000
2. SOLIDIFICATION				
Flyash (Transport)	2,000	CY	$6.00	$12,000
Flyash (Placement)	2,000	CY	$2.08	$4,160
Flyash (Mixing)	4,000	CY	$2.46	$9,840
			SUBTOTAL	$26,000
			TOTAL {1}	$270,000
			ROUND	$270,000

{1} Indirect capital costs and contingencies for the complete sediment dredging are included in the summary for overall remedial alternatives.

TABLE 6-28. Estimated Capital Costs for Containment Under Remedial Alternative 6.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. SOIL COVER (SEDIMENTS)				
Borrow (Transport)	39,400	CY	$5.00	$197,000
Borrow (Placement)	39,400	CY	$9.82	$386,908
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$616,628
2. SINGLE BARRIER CAP (FSPSA)				
Fill (Transport)	16,300	CY	$11.36	$185,168
Fill (Placement)	22,500	CY	$2.08	$46,800
Membrane (40 mil HDPE)	610,000	SF	$0.50	$305,000
Geonet	610,000	SF	$0.26	$158,600
Geotextile (10 oz.)	1,220,000	SF	$0.18	$219,600
Borrow (Transport)	30,000	CY	$5.00	$150,000
Borrow (Placement)	30,000	CY	$9.82	$294,600
Hydroseed	610,000	SF	$0.04	$24,400
			SUBTOTAL	$1,384,168
3. CONSOLIDATE CRDA IN CMSD				
Clearing/Grubbing	4.5	acre	$2,800	$12,600
Excavation	5,700	CY	$6.15	$35,055
Borrow (Transport)	3,600	CY	$5.00	$18,000
Borrow (Placement)	3,600	CY	$9.82	$35,352
Hydroseeding	195,000	SF	$0.04	$7,800
			SUBTOTAL	$108,807
			TOTAL {1}	$2,109,603
			ROUND	$2,100,000

{1} Indirect capital costs and contingencies for the containment systems are included in the summary for overall remedial alternatives.

Table 6-29. Estimated Capital Costs for Thermal Treatment Under Remedial Measure CMSD-7.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. TREATMENT SYSTEM MOBILIZATION	1	LS	$175,000	$175,000
2. SITE PREPARATION				
Concrete	1	LS	$320,000	$320,000
Clearing/Grubbing	6.2	acre	$2,800	$17,360
Grading		LS	$120,000	$120,000
			SUBTOTAL	$457,360
3. SIZE REDUCTION EQUIPMENT	1	LS	$60,000	$60,000
4. PRESENT WORTH OF THERMAL TREATMENT (See Table 6-32)				$67,800,000
5. UTILITIES	1	LS	$40,000	$40,000
			TOTAL {1}	$68,532,360
			ROUND	$69,000,000

{1} Indirect capital costs and contingencies for the thermal treatment system are included in the summary for overall remedial alternatives.

- Table 6-30: Present Worth of Containment for CMSD Following Thermal Treatment Under Remedial Measure CMSD-7

6.7.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 6 are summarized in Table 6-31. The O&M costs for the ground-water extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M costs for thermal treatment of the CMSD material are presented in Table 6-32.

6.7.7.3 Present Worth

The present worth of Remedial Alternative 6 was calculated to be $123,000,000. This value was calculated in accordance with USEPA guidance[72] utilizing an operating period of 30 years and a discount rate of 10 percent.

6.8 Remedial Alternative 7

Remedial Alternative 7 constitutes a treatment and containment alternative for the Ormet site. This alternative was assembled by combining the following remedial measures:

- GW-3: Pumping of Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;

[72]USEPA, 1987.

TABLE 6-30. Present Worth of Containment for CMSD Following Thermal Treatment Under Remedial Measure CMSD-7.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. SINGLE BARRIER CAP (CMSD)				
Fill (Placement)	5,000	CY	$2.08	$10,400
Grading	77,000	CY	$8.23	$633,710
Membrane (40 mil HDPE)	243,000	SF	$0.50	$121,500
Geonet	243,000	SF	$0.26	$63,180
Geotextile (10 oz.)	486,000	SF	$0.18	$87,480
Borrow (Transport)	12,000	CY	$5.00	$60,000
Borrow (Placement)	12,000	CY	$9.82	$117,840
Rip-Rap	860	T	$31.85	$27,391
Hydroseeding	243,000	SF	$0.04	$9,720
			TOTAL	**$1,131,221**
			ROUND	**$1,100,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
To Be Constructed in Year 10	$436,000

TABLE 6-31. Summary of O&M Costs for Sitewide Remedial Alternative 6

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
	SUBTOTAL	$961,570
Administration (12%)		$115,388
	SUBTOTAL	$1,076,958
Contingency (20%)		$215,392
	TOTAL	$1,292,350
	ROUND	$1,300,000

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
30 Year Operation with Ground-Water Treatment	
O&M for Years 1-10 Included in Capital	
Cost of Alternative.	$5,400,000

TABLE 6-32. Estimated Treatment Costs Under Remedial Measure CMSD-7.

COST ELEMENT	ESTIMATED ANNUAL QUANTITY	UNIT	UNIT COST	ANNUAL TOTAL COST
1. THERMAL TREATMENT				
Excavation	22,800	CY	$6.15	$140,220
Placement	22,800	CY	$3.10	$70,680
Treatment	34,200	ton	$300	$10,260,000
Ash Placement	19,380	CY	$3.10	$60,078
			SUBTOTAL	$10,530,978
2. OFF-SITE DISPOSAL				
Excavation	1,200	CY	$25	$30,000
Placement	1,200	CY	$3.10	$3,720
Transport	1,800	ton	$37	$66,600
Disposal	1,800	ton	$230	$414,000
			SUBTOTAL	$514,320
			TOTAL PER YEAR {1}	$11,045,298
			ROUND	$11,000,000
			TOTAL (10 YEARS)	$110,000,000

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
10 Year Operation	$67,800,000

{1} Indirect costs and contingencies for O&M of the thermal treatment systems are included in the summaries for the remedial alternatives.

- SP-4: Collection of the Ballfield and CMSD Seeps Using Trench Drains, Treatment of the CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-6: Treatment by In-situ Soil Flushing and Containment by Vegetated Soil Cover;
- FDP-7: Solidification and Containment by Dual Barrier Cap;
- CMSD-7: Complete Excavation, Treatment by Thermal Oxidation, and Containment by Single Barrier Synthetic Capping;
- CRDA-5: Excavation and Treatment by Thermal Oxidation; and
- SED-9: Complete Dredging, Treatment by Solvent Extraction, Consolidation with CMSD Containment by Single Barrier Synthetic Cap.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.8.

6.8.1 Compliance with ARARs

The ability of Remedial Alternative 7 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.8.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat ground water pumped by the existing interceptor wells prior to discharge to the Ohio River. Specifically, effluent from the lime/ferrous salt precipitation treatment system would comply with NPDES effluent limitations currently proposed for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale studies of this technology. Fluoride concentration reductions were also achieved in the pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

This remedial alternative could achieve chemical-specific ARARs for aquifer quality. Treatment of the soil in former spent potliner storage area would transfer constituents from the soil into the underlying ground water, where they would be extracted by the interceptor wells. This component of Remedial Alternative 7, coupled with containment of the former disposal ponds and ground-water extraction could eventually achieve MCLs and MCLGs in the alluvial aquifer.

Remedial Alternative 7 would also be subject to various relevant and appropriate chemical-specific requirements. Thermal treatment of the materials contained within the CMSD and the carbonaceous material from the carbon run-off and deposition area would be subject to the following requirements:

- OAC 3745-17-02(A,B,C): Establishes specific standards for total suspended particulate emissions.

- OAC 3745-17-05: Sets forth the non-degradation policy for particulate.

- OAC 3745-17-07(A-D): Specifies the allowable opacity for visible particulate emission.

- OAC 3745-17-09(A,B,C): Establishes particulate emission limitations and odor restrictions for incinerators.

- OAC 3745-18-06(A-G): Establishes limitations for sulfur dioxide emissions.

- OAC 3745-21-08(A-E): Establishes requirements for minimization of carbon monoxide emissions from stationary sources.

Remedial Alternative 7 would comply with these requirements.

Remedial Alternative 7 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and treated by thermal oxidation. The carbonaceous material in the CRDA is not itself a hazardous waste, therefore, on-site containment of the resulting ash would not be subject to LDRs as ARARs. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Carbonaceous material identical to that present in the CRDA is routinely sampled to determine whether it exhibits characteristics which would qualify it as a RCRA characteristic waste. This material has never exhibited hazardous characteristics.

6.8.1.2 Location-Specific ARARs

Remedial Alternative 7 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid wastes in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[73]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

Remedial Alternative 7 would comply with the floodplain ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and treated by thermal oxidation.

6.8.1.3 Action-Specific ARARs

Implementation of this remedial alternative would require attaining various action-specific ARARs. Operation of the Ormet Ranney well and the existing interceptor wells would also be subject to certain action-specific ARARs under Remedial Alternative 7. Specific maintenance

[73]USEPA, 1988d.

requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 7 would comply with these requirements.

Treatment of the interceptor well water under Remedial Alternative 7 would also be subject to action-specific ARARs. This remedial alternative would comply with any Permit-to-Install requirements, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Treatment of the materials contained within the CMSD and the carbonaceous materials in the carbon run-off and deposition area by thermal oxidation utilizing a transportable rotary kiln incinerator would be subject to various relevant and appropriate action-specific requirements. Specifically, rotary kiln incineration of these wastes would be subject to the following design and performance standards for incineration:

- OAC 3745-50-44(C8): Substantive permit requirements for incineration.
- OAC 3745-50-62(A-D): Specifies trial burn requirements for incinerators.
- ORC 3734.02(I): Establishes air emission requirements for particulate matter, dust, fumes, gas, mist, smoke, vapor, and odorous substances.
- OAC 3745-15-07(A): Defines and prohibits air pollution nuisances.
- OAC 3745-16-02(B,C): Establishes allowable stack height requirements for air emission sources based on good engineering practice.
- OAC 3745-23-06: Establishes requirements for minimization of nitrogen oxide emissions from stationary sources.

- OAC 3745-23-04: Prohibits the significant and avoidable deterioration of air quality by the release of nitrogen oxide emissions.

Remedial Alternative 7 would comply with the majority of these requirements. Thermal treatment of medial containing cyanide would result in emissions of nitrogen gas. Appreciable amounts of NO_x may exist[74]. Monroe County is in attainment for NO_x and is covered by the NO_x non-degradation ARAR. Commercially available transportable rotary kiln incinerators are not equipped with air pollution control equipment to remove NO_x. However, air pollution control equipment could be added to the incinerator to reduce NO_x emissions. Therefore, this remedial alternative would achieve the NO_x non-degradation ARAR.

Off-site landfilling of the ground-water treatment residuals would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 7 would comply with these requirements.

The single barrier cap that would be constructed over the CMSD would attain or exceed State of Ohio ARARs for solid waste. As provided in OAC 3745-27-11(G)(1), the cap design illustrated in Section 5 would include materials of construction that are comparable to those identified under OAC 3745-27-08 and 3745-27-11.

The cap that would be constructed over the FDPs would attain RCRA Subtitle C and State of Ohio hazardous waste ARARs pertaining to closure of hazardous waste facilities. The dual barrier cap design illustrated in Section 5 would meet, or be equivalent to, the cap construction requirements specified under 40 CFR264.221 and 40 CFR264.228 and OAC 3745-57-10.

Capping the CMSD under this remedial alternative would not necessitate explosive gas monitoring because construction materials are generally not putrescible. Wooden scrap that was

[74]Kiang and Metry, 1982.

emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. Air monitoring performed during test pit excavation in the CMSD did not detect the presence of explosive gases.

Remedial measures for the sediments in the Outfall 004 backwater area under this alternative would attain action-specific ARARs regarding PCBs. Additionally, the cleanup goals for PCBs and PAHs identified in Appendix F (TBC information) would be attained in the backwater area under this alternative through complete dredging. Under this alternative, soils containing PCBs and PAHs at concentrations greater than the SQCs (see Appendix F) would be excavated from the backwater area. Furthermore, the excavated materials from the backwater area would be treated by solvent extraction and contained in the CMSD under a single barrier cap. Treatment extract concentrated in PCBs would be disposed of off-site by incineration. This would attain compliance with the disposal requirements under TSCA for liquid PCBs. After treatment the solid residuals would contain less than 2 mg/kg PCBs and as such, the chemical waste landfilling requirements under TSCA are not ARARs for this alternative. Following removal, the excavated area would be sampled to confirm that the cleanup goals have been achieved.

6.8.2 Overall Protection

The protectiveness of Remedial Alternative 7 for human health and the environment would be very similar to Remedial Alternatives 3 through 6. The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;

- ingestion of contaminated media from all areas of concern;

- direct contact with contaminated media from all areas of concern;

These exposure pathways would be effectively addressed under Remedial Alternative 7 for all areas.

6.8.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 7 is described in the following sections.

6.8.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 7 could be largely achieved within ten years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the existing interceptor wells represents current conditions. Effective treatment of the extracted ground water would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 7 includes 19 months for engineering design and construction following issuance of a permit to install.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the

CMSD seeps could be potentially completed within 1 to 2 years. Furthermore, it is possible that the seeps would eventually disappear after treatment and capping of the CMSD.

Implementation of the solvent extraction process on the 2,000 CY of dredged sediments from the Outfall 004 backwater area could be complete in a relatively short timeframe. The vendor of the solvent extraction process considered in this FS indicated that treatment of these sediments could be completed in 1 to 2 months following completion of design and procurement.

Remedial Alternative 7 includes treatment of the pond solids by in-situ solidification and the materials in the CMSD by thermal oxidation. Processing rates for in-situ solidification are approximately 1200 CY/8 hour day[75]. Solidification of the pond solids and sediments could be completed within 1 to 2 years. Inquiries to vendors of transportable rotary kiln incinerators indicated that thermal treatment processing rates are highly variable and can range from 100 to 225 tons per day. Assuming a density of 1.5 tons per cubic yard, approximately 4 to 10 years would be required for treatment of the CMSD. The timeframe for this remedial measure would be expected to be in the upper portion of this range due to the need to pre-process the material in the CMSD prior to thermal treatment. The use of multiple units for treating the CMSD in an effort to reduce the timeframe for this component of Remedial Alternative 7 is not practical due to space limitations and the potential for increased air emissions.

Remedial Alternative 7 also involves several containment structures including single and dual barrier caps, and steel sheet piling. These structures could be constructed within 2 to 3 years. The estimated construction time for capping was developed assuming sequential capping of the former disposal ponds, the CMSD, and containment of the Outfall 004 backwater area sediment.

[75]Cullinane, et. al, 1986.

Administrative requirements governing permitting of dredging activities under this remedial alternative would extend the timeframe for achieving protection. The extent of this increase in the time required for implementation is not known, but may be on the order of one to three years.

The implementation time for in-situ flushing of the soils in the former spent potliner storage area is not known due to the relatively limited information on this technology. Under this alternative, it has been assumed that the soil flushing system would operate for a period of 10 years. The actual implementation time would be indicated by asymptotic decreases in monitoring parameters.

6.8.3.2 Short-Term Reliability

Remedial Alternative 7 would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1958) and the existing interceptor wells (installed in 1972). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.8.3.1, approximately 19 months after issuance of a PTI will be required for construction of a treatment system under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the treatment component of this alternative is addressed in Section 6.8.4.3.

Treatment of the dredged sediments by solvent extraction would be reliable in the short-term. The treatment would be completed in 1 to 2 months following completion of design and procurement.

Thermal treatment of the materials from the CMSD and the carbon run-off and deposition area under this remedial alternative would not be performed in the short-term. As discussed in Section 6.8.3.1, thermal treatment would require approximately four to ten years for implementation under this alternative. Thermal treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the treatment component of this alternative is addressed in Section 6.8.4.3.

Solidification of the solids in the former disposal ponds and containment of the former disposal ponds, the CMSD, and the Outfall 004 backwater sediments would not be performed in the short-term. As discussed in Section 6.8.3.1, approximately 1 to 2 years will be required for solidification of the pond solids and sediments. Additionally, 2 to 3 years will be required for containment of these areas. Therefore, solidification and containment of these areas would be initiated in the mid-term, and would continue over the long-term. The reliability of this component of Remedial Alternative 7 is addressed in Section 6.8.4.3.

6.8.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The treatment and containment components of Remedial Alternative 7 will require excavation of the CMSD, regrading of the former spent potliner storage area and the former disposal ponds, dredging of the sediments from the Outfall 004 backwater area and solidification of the former disposal ponds. These activities could result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the Outfall 004 water, which includes untreated ground water extracted by the existing interceptor wells demonstrated that this water is not acutely toxic to aquatic organisms.

No air emissions are associated with treatment of the dredged sediments from the Outfall 004 backwater area by solvent extraction. Therefore, the health and safety of the community would not be adversely impacted by the solvent extraction component of Remedial Alternative 7.

Implementation of this remedial alternative would result in air emissions from the thermal treatment equipment. Air pollution control equipment would be added to reduce NO_x emissions. This alternative would be protective of the health and safety of the community because of the air pollution controls that would be utilized.

There is no possibility that implementation of this alternative would generate toxic gases. Ground-water treatment would be performed at alkaline pH, therefore, the generation of HCN gas is not possible. None of the other treatment or containment components of this alternative would result in the possible generation of toxic reaction by-products.

6.8.3.4 Worker Protection

Implementation of Remedial Alternative 7 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the CMSD and CRDA to restrict fugitive dust emissions. Dredging of the Outfall 004 backwater sediments is not expected to generate significant dust unless the sediments are allowed to dry, at which point dust suppressants may also be used on the sediments. Given the large amount of excavation activity, the possibility for fugitive dust generation is high. However, because dust suppressants would be utilized the amount of dust possibly generated cannot be estimated, but inhalation exposure during the periods of excavation and transfer are expected to be minimal. Appropriate protective equipment would be utilized during the period of excavation and material handling to provide additional protection of the workers.

6.8.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and
- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppresants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

6.8.4 Long-Term Effectiveness

This remedial alternative would be protective of human health and the environment over the long-term. The long-term effectiveness considerations related to implementation of Remedial Alternative 7 are discussed in the following sections.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative includes ground-water remedial measure GW-3, which consists of pumping of the Ormet Ranney well and existing interceptor wells to control and recover the plume, followed by treatment of the extracted ground water using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in that portion of the alluvial aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years under current site conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations is provided in Appendix K. Soil flushing of the FSPSA under Remedial Alternative 7 is expected to decrease this timeframe. This is due to the enhanced leaching of constituents in the unsaturated zone, resulting in a more rapid transfer of contaminants from the unsaturated soils to the ground-water system. Due to uncertainties regarding the effectiveness of the soil flushing, the extent to which the aquifer restoration time can be reduced by soil flushing of the FSPSA cannot be reliably predicted.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the single barrier caps would promote run-off and evapotranspiration. Infiltration modelling was performed for the single barrier caps (see Appendices I and J). For the FSPSA, regrading and construction of the single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to approximately a 99.5 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to a 99.4 percent reduction over existing conditions. This alternative would be effective in reducing the infiltration of precipitation through the soils in the former disposal ponds. Regrading of the ponds and construction of the dual barrier caps over the FDPs would promote run-off and evapotranspiration to the same extent as the dual barrier caps discussed in Section 6.5.4. Based on these results, leachate generation in these areas would be virtually eliminated.

6.8.4.1 Reduction of Assumed Existing Risks

Similar to Remedial Alternative 2, implementation of Remedial Alternative 7 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the soils would be eliminated by the construction of the single barrier and dual barrier caps. Direct contact with the soils beneath the caps would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted soils beneath the single barrier or dual barrier caps, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the existing interceptor wells and treatment of the captured ground-water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the caps.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Dredging of the sediments from the Outfall 004 backwater area, followed by treatment, and consolidation with the CMSD material under a single barrier synthetic cap would prevent direct exposure to constituents in sediments and prevent future releases from the backwater area to the river. Human and wildlife exposure to the backwater sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would also be eliminated. Therefore, the risk to humans associated with ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater area is dredged and contained in the CMSD, and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over time as the sediments are covered by background river sediments. Constituents in the Outfall 004 backwater area would be removed, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.8.4.2 Magnitude of Future Risks

Similar to Remedial Alternative 2, constituents in the alluvial ground water would be collected and treated under Remedial Alternative 7. Future hypothetical exposure of plant worker, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated ground water as a source of potable water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3, reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and CMSD. Future exposure of child and adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential for exposure to any constituents that might still leach from the underlying media after the single barrier and dual barrier caps are installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

The soil cover over the former spent potliner storage area, the single barrier cap over the CMSD (with the consolidated and treated carbonaceous material from the carbon run-off and deposition area and the dredged sediments), and the dual barrier cap on the former disposal ponds, would prevent the emission of fugitive dust and eliminate direct contact exposure to the impacted media. The single barrier and dual barrier caps over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. With the exception of deep burrowing animals, the single barrier and dual barrier cap would preclude exposure of most terrestrial organisms. It is possible that the affected media may also act as a deterrent to burrowing animal activity. The single barrier and dual barrier caps form physical barriers that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the routine maintenance of the single barrier and dual barrier caps would include control of burrowing animals through baiting and removal of seedling trees that might take root at the site. Infiltration through the caps could mobilize some of the constituents in the subsurface soils, however, as discussed in the preceding paragraph, these constituents would pose zero risks to humans or wildlife.

Dredging of the Outfall 004 backwater sediments, treatment, and containment within the CMSD beneath a single barrier cap would eliminate the potential for future exposure to constituents in the sediments. Because the 004 backwater area is an embayment of the Ohio River, relocation of the 004 outfall stream prior to sediment removal would not eliminate benthic habitat. Dredging of the sediments would temporarily disrupt the benthic habitat in the backwater area. However, because the backwater area is an embayment, resedimentation and the associated restoration of benthic habitat would occur relatively rapidly. The overall effect of these actions would be that exposure to constituents in the backwater area would be eliminated. Food chain exposures associated with the Outfall 004 backwater area would also be eliminated. Dredging of the Outfall 004 backwater area would eliminate the potential for future releases to the Ohio River, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments. Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases.

In summary, the remedial measures that comprise Remedial Alternative 7 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.8.4.3 Long-Term Reliability

Remedial Alternative 7 would be reliable over the long-term. As discussed in Section 6.8.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the interceptor wells has performed reliably since installation of these wells. In consideration of the in-line redundancy in the ground-water extraction system, ground-water containment over the long-term is expected to be highly reliable.

Solidified materials are subject to breakdown due to natural weathering. Sulfate-rich ground water can cause swelling and disintegration of solidified waste, or leaching by rainwater can remove buffering materials in a solidified waste allowing the pH to decrease such that metals are resolubilized in the contacting water[76]. Capping of the pond solids following solidification would aid in maintaining the long-term reliability of the solidification component of Remedial Alternative 7.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control[77]. Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

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[76]Cullinane, et.al, 1986.

[77]Baker/TSA, Inc. 1990.

Long-term reliability of dual barrier caps utilizing clay and/or synthetic membrane materials of construction and single barrier synthetic caps has been proven, dependent upon adequate post-closure maintenance. The reliable life expectancy of dual barrier (i.e., RCRA) caps and standard (i.e., single barrier) landfill caps with normal maintenance is approximately 50 to 100 years (Versar, Inc. 1991). These caps are susceptible to settlement and cracking, wind and water erosion, root penetration, burrowing animals, and accidental or intentional intrusion. Proper QA/QC during cap construction and routine maintenance can reduce damage to the cap. Standard engineering practice of installing geotextile fabric between the vegetated layer and drainage layer, coupled with vegetating the cover with grasses that do not have deep roots, will aid in preventing root penetration. Animals that currently live on-site would be controlled prior to capping (OAC 3745-27-11 (G)(4)). The geotextile fabric and geonet will also aid in preventing the animals from burrowing into the cap. A well-maintained vegetative cover, periodic inspections and limited site access will ensure reliable long-term performance of the single barrier synthetic and dual barrier caps. Synthetic membranes exhibit a high degree of chemical resistance and are capable of elongating up to 500 percent (National Sanitation Foundation Standard Number 54). Unless atypical settlement or depressions develop, integrity of the synthetic membrane will not be comprised by settlement.

The long-term reliability of in-situ soil flushing is not known due to the fact that this technology has not been applied over the long-term at other sites. However, the systems for conveyance and application of the flushing water are relatively simple and are therefore expected to be reliable over the long-term. The long-term reliability of this component of Remedial Alternative 7 could be decreased by channelling effects in the soil. If preferential flow paths (or channels) are established in the soils, localized volumes of soil may not be contacted by the flushing water. This effect could result in reduced ability to remove soluble constituents from soil reliably over the long-term. However, given the nature and texture of the soils that are predominant beneath the former spent potliner storage area (i.,e., sands and gravels), channeling effects may be limited. These effects may be further limited by the method of applying water to the soils that would be employed under this remedial alternative. Spray application would facilitate even distribution of water across the surface of the former spent potliner storage area.

CERCLA requires a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required.

6.8.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney well and the interceptor wells will effectively contain the ground water plume under the Ormet site. Treatment of the ground water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce constituent concentrations in the extracted ground water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. Future exposure to the constituents in the ground water at the site will be prevented by the pumping and treatment components of this remedial alternative. As discussed in Section 6.8.4, regarding the remediation of ground water, restoration of ground-water quality will require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property.

The vegetated cover over the former spent potliner storage area, the single barrier cap that would be provided over the CMSD and the dual barrier cap over the former disposal ponds under this remedial alternative will eliminate infiltrate and transport of constituents from these areas.

Pumping and treating of the alluvial ground water, capping with dual barrier and single barrier synthetic caps, and concrete revetments over the Outfall 004 backwater area sediments will eliminate direct contact exposure, prevent releases to the air, and can effectively eliminate infiltration and transport. Therefore, Remedial Alternative 7 will eliminate or significantly reduce future exposure to the constituents present at the Ormet site.

6.8.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Additionally, the potential need to replace the components associated with the in-situ soil flushing system is low due to the relative simplicity of the equipment that would be employed. Potential for repair of dual barrier caps utilizing bentonite admixture and synthetic membrane materials of construction will be limited to periodic maintenance of the soil cover. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, control of burrowing animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the cap components.

6.8.5 Reduction of Mobility, Toxicity, and Volume

Remedial Alternative 7 would result in removal of constituents for the ground water extracted by the interceptor wells, as well as for the CMSD seeps. Toxicity reductions would also result from thermal treatment of the carbonaceous material from the carbon run-off and deposition area and the materials in the CMSD. Limited volume reductions would result from implementation of Remedial Alternative 7. Volume reduction of the materials in the CMSD would result from pre-processing for size reduction. Little volume reduction would result from thermal treatment of this material because of the predominant presence of firebrick and other inert materials that would not be combusted. Thermal treatment of the carbonaceous material would result in significant volume reduction because the carbonaceous substrate would be converted into carbon dioxide.

Solidification of the solids in the former disposal ponds would be performed primarily to improve geotechnical properties. This treatment would increase the volume of these materials by 25 to 75 percent. For example, the 370,000 CY present in Pond 5 would increase to approximately 460,000 to 650,000 CY (Table 6-13). Due to the volumetric increase resulting from solidification, additional material would not be required to fill the ponds to grade for capping under this remedial alternative. Secondarily, the mobility of the various organic and inorganic constituents present in the solids from the former disposal ponds could be reduced by solidification depending upon the treatment agents selected.

Treatment of the dredged sediments by solvent extraction would not result in any volume reduction. However, the toxicity of organic constituents in the sediments would be reduced by extraction and subsequent thermal treatment. The effects that this treatment would have on the mobility of inorganics in the solid treatment residuals is not known.

6.8.5.1 Quantities Treated or Destroyed

Ground water extracted by the interceptor wells is one of several media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

A second medium that would be treated under Remedial Alternative 7 is the seep water. Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately 1.3 million gallons per year. However, it is possible that the seeps would eventually disappear with treatment and capping of the CMSD.

The total volume of soil in the former spent potliner storage area would be treated by in-situ flushing under this remedial alternative. Approximately 800,000 cubic yards of soil would be treated by in-situ flushing under this alternative.

The solids in the former disposal ponds would also be treated under Remedial Alternative 7. Using the Pond areas stated in Table 2-2 and the isopach maps presented in Figures 4 through 7 of the RI Report, approximately 420,000 CY of pond solids will be solidified prior to capping.

Under Remedial Alternative 7, approximately 2,000 CY of dredged sediments from the Outfall 004 backwater area would be treated by solvent extraction.

This remedial alternative would include treatment of approximately 228,000 CY of material from the CMSD. This quantity represents the total quantity of material in the CMSD (240,000 CY) less the quantity of bulky materials that would be sorted out prior to thermal treatment (12,000 CY). As discussed in Section 5, the sorted materials would be addressed by off-site landfilling. Excavated material from the CRDA would undergo thermal treatment along with the CMSD materials. Excavated material from the CRDA would undergo thermal treatment along with CMSD materials

This remedial alternative would include treatment of approximately 228,000 CY of material from the CMSD. This quantity represents the total quantity of material in the CMSD

(240,000 CY) less the quantity of bulky materials that would be sorted out prior to thermal treatment (12,000 CY). As discussed in Section 5, the sorted materials would be addressed by off-site landfilling.

6.8.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the existing interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot plant conditions to effluent concentrations of 0.19 to 0.89 mg/L[78]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced under carefully controlled pilot plant conditions to 10 to 15 mg/L[79]. This corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

Under this remedial alternative, oil present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

Solidification of the solids from the former disposal ponds would be achieved using a pozzolanic material, such as lime or fly ash. Solidification utilizing pozzolanic materials, has

[78]Baker/TSA, Inc., 1990.

[79]Baker/TSA, Inc., 1990.

shown to be effective for metal sludges[80]. Lime based and lime/flyash processes are able to accommodate large quantities of organics as well as inorganic sludges[81].

The degree of expected reductions in constituent concentrations that would result from in-situ flushing of the soils in the former spent potliner storage area is not known due to the limited data available on this technology. Studies have shown that in-situ soil flushing is most effective in highly permeable soils with low organic content. Based on the RI report, the former spent potliner storage area may meet these criteria. Therefore, this technology may result in significant reductions for soluble soil constituents.

Thermal treatment of approximately 228,000 CY of material from the CMSD would yield significant concentration reductions for organics and cyanide present in the CMSD. A DRE of 99.99% could be achieved for these substances using a transportable rotary kiln incinerator.

After thermal treatment a single barrier cap over the CMSD would be utilized. Infiltration would be reduced thus eliminating or significantly decreasing generation of the seeps. Following capping, the seeps may stop discharging entirely.

6.8.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the sludge would be removed from the system and disposed off-site. Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

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[80]USEPA, 1989i.

[81]Conner, 1990.

Reduction of the pH of the stabilized material may cause the metals to be taken out of solution. Natural weathering may also cause the stabilized material to disintegrate. However, the dual barrier caps over the former disposal ponds will aid in preventing these problems from affecting the stabilized pond solids.

Thermal destruction of the organics and cyanide present in the CMSD is an irreversible process. This component of Remedial Alternative 7 would destroy organics forming simple inorganics such as carbon dioxide and water. These substances cannot be recombined to yield the constituents present in the CMSD.

Solvent extraction of the organics present in the sediments is also a permanent treatment method. The PAHs and PCBs present in the sediments would be permanently removed. Additionally, thermal treatment of the organic liquid residuals would permanently destroy these constituents.

6.8.5.4 Treatment Residuals

Treatment residuals resulting from the precipitation process consist of dewatered sludge. Baker/TSA, Inc. estimated that full scale operation would yield approximately three tons per day of dewatered sludge (filter cake)[82]. Samples of the sludge from the pilot plant were collected and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[83].

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the adsorber vessels. The amount of free-phase oil observed on

[82]Baker/TSA, Inc., 1990.

[83]Baker/TSA, Inc., 1990.

the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5, it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

Treatment residuals would also be generated by solvent extraction of the dredged sediments. These residuals would include:

- organic liquid containing PAHs and PCBs;
- water containing dissolved inorganics;
- solids containing inorganics.

The vendor of this technology indicated that the quantity of organic liquids would be approximately 40 CY. This equates to 150 55-gallon drums of organic liquid residuals. The quantity of water resulting from this treatment process varies depending upon the water content of the material being treated. The quantity of residual solids would be approximately 2,000 CY.

Based on visual observations during test pit excavations in the CMSD, the material to be treated consists largely of fire-brick, steel, some wood and other construction and demolition debris. Due to the nature of this material, it is estimated that only minimal volume reductions (i.e., 10 to 20 percent) will occur during thermal treatment. The material to be excavated from the CRDA consists almost exclusively of carbonaceous material (i.e., spent anode comprised of calcined coke). Therefore, a volume reduction of 90 percent or greater is anticipated during thermal treatment of the carbonaceous material excavated from the CRDA.

6.8.6 Implementability

Remedial Alternative 7 is potentially implementable within site conditions.

6.8.6.1 Constructability and Operability

This remedial alternative is operable within site conditions but poses certain constructability problems due to the solids in Pond 5. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance, and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by any of the existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps. However, construction of the solvent extraction process equipment would be difficult because sufficient space is not available in the vicinity of the sediments for the required equipment, staging pads, support facilities and ancillary equipment.

Construction of dual barrier caps over the former disposal ponds and a single barrier synthetic cap over the CMSD would require specialized equipment and skilled personnel. Specialized equipment would be required to performed the stabilization/solidification of the pond solids prior to capping. The dual barrier cap utilizing a synthetic membrane as the second barrier layer also requires specialized equipment for welding the seams of the membrane. This equipment would be utilized under the supervision of a qualified specialty installer.

Treatability studies would be required to show the level of removal that is achievable for implementing soil flushing in the former spent potliner storage area. Bench scale and field studies would need to be performed on a plot at the site.

Under Remedial Alternative 7, solidification of the solids from the former disposal ponds would be accomplished using backhoes, crawler-mounted injector-type mixers or a vertical auger mixer/injector[84]. Because of the size of Pond 5, clamshell or dragline equipment would probably be required to ensure an adequate reach for mixing the contents of Pond 5 with the solidification agents. Access for this type of equipment would be difficult along the berm of Pond 5 bordering the Ohio River due to the narrowness of the berm. To address the equipment access problem, Pond 5 could potentially be solidified by working progressively from the side adjacent to the former spent potliner storage area toward the river. This progressive approach would not prohibit the use of the equipment described above. The clamshell and dragline equipment required for this purpose is available. The lime and flyash reagents that would be used for solidification under Remedial Alternative 7 are available in the Ohio River valley region. Treatability studies would be required to determine appropriate mixing ratio of the materials in the former disposal ponds with lime and fly ash for solidification. Prior to capping, the solidified residuals would be regraded to provide approximately a 4 percent slope for surface water run-off.

The sediments from the Outfall 004 backwater area could potentially be dredged in the following manner. A crawler-mounted clamshell could be maneuvered to the toe of the CMSD. This equipment would dredge the sediments from the Outfall 004 backwater area and place them on top of the CMSD for treatment by solvent extraction. Once situated on top of the CMSD, earthmoving equipment could be utilized to move the sediments to the solvent extraction equipment. Treatability studies would be performed to determine the efficiency of solvent extraction on the dredged sediments.

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[84]Connor, 1990.

Thermal treatment of the material in the CMSD would be difficult to implement. The large amount of material handling, sorting, and pre-processing would require a number of temporary storage pads. Sufficient space is not available in the vicinity of the CMSD for these storage pads, as well as for the thermal processing equipment, ash storage pads, ancillary equipment, and support facilities. Due to the proximity of the CMSD to the river, operational controls would be required to prevent sloughing of materials into the river during excavation activities. An ultimate analysis of the CMSD and CRDA material would be required to determine the percentage of combustible products formed from incineration. A trial burn would also be required to determine the destruction and removal efficiency.

As discussed in Section 6.8.3.2, the ground-water extraction system has operated reliably since installation of the Ormet Ranney well and the existing interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

Pilot studies have demonstrated that treatment of the ground water extracted by the interceptor wells requires careful process control[85]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation. Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

There are no operability considerations associated with the containment components of Remedial Alternative 7. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

[85]Baker/TSA, Inc., 1990.

6.8.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 7 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements of Remedial Alternative 7 could be managed as operable units:

- ground-water extraction and treatment;
- seep collection and treatment;
- excavation and treatment for the CMSD;
- containment measures for the former disposal ponds; and
- dredging and treatment of the sediments.

Several of these component remedial measures must be implemented sequentially. For example. Similarly, dredging and treatment of the sediments must be performed prior to capping of the CMSD because the sediment treatment residuals will be contained in the CMSD.

6.8.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 7 could be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water extraction system continues to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Additionally, these wells could be used to monitor constituent removal under the in-situ soil flushing component of this alternative. Periodic ground-water quality data will also provide the best means of adjusting projects of the time required to achieve reductions in contaminant concentrations.

Cap inspections would be performed to monitor the integrity of the cap barrier. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding, and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized effectively to monitor the chemical composition and concentrations of the discharges.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The CRDA material would be excavated and treated off-site. Additional remedial actions for ground water, seeps, and former spent potliner storage area would require modifications to the treatment systems. Changes of this nature would be difficult to implement. Sediments would be treated using solvent extraction. The residual material would be capped within the CMSD. The CMSD materials would be thermally treated prior to capping. The residual material from both of these treatment processes would be in an altered state from the original material. This is similar for the former disposal pond solids, which will also be stabilized prior to capping. Thus, further remedial action on these treated media would be difficult.

6.8.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 7. Approvals would be required for construction of the ground-water treatment system for the interceptor wells that is included in this remedial alternative. Approval to construct this system would be in the form of a Permit-to-Install. Similarly, a PTI may be required for the CMSD seep collection and treatment system, and the ballfield seep collection system. Approvals would also be required for discharges to surface-water under the NPDES program. The NPDES permit for the Ormet facility will govern discharge to surface water under this remedial alternative.

Thermal treatment of the materials located in the CMSD will be performed entirely as an on-site response action. As such, thermal treatment will not require permitting according to the site response CERCLA Regulations. CERCLA Section 121(e) states that on-site response actions may proceed without obtaining permits or other administrative requirements. However, the thermal treatment component of this remedial alternative will require compliance with substantive requirements of action-specific ARARs for incinerators. For example, before commencing incineration, a trial burn will have to be conducted according to OAC 3745-50-62 in order to determine emissions and operating conditions for the incinerator.

Similarly, treatment of the dredged sediments by solvent extraction would not require permitting according to the site response CERCLA regulations. Air emission permits would not be required because air emissions would not be generated from this process. Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.8.6.5 Availability of Off-Site Services and Capacity

Off-site transportation and disposal services would be required for the treatment residuals discussed in Section 6.8.5.4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these residuals exist within USEPA Region V[86]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. The same would be true for any organic liquids resulting from solvent extraction of the dredged sediments. Due to the potential presence of PCBs in the oil, it has

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[86]USEPA, et. al., 1990.

been assumed that the oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[87]. Adequate disposal capacity is commercially available.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 7. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

6.8.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

Specialized equipment and skilled workers would be required for solidification of the solids from the former disposal ponds. Specialized equipment is required for thermal treatment of the CMSD and the carbonaceous material from the carbon run-off and deposition area. A transportable rotary kiln incinerator and grinding equipment would be needed for implementation of Remedial Alternative 7. Similarly, specialized treatment equipment would be required for solvent extraction of the dredged sediments. All of the specialized equipment identified above is commercially available.

[87]USEPA, et. al., 1990.

Specialized equipment and skilled workers would be required for installation of the single and dual barrier caps over the former disposal ponds under this remedial alternative. However, the required materials and services are available through a variety of commercial sources.

Skilled workers and specialized equipment would not be required for implementation of the in-situ soil flushing component of Remedial Alternative 7. The equipment required for this system includes a transfer pump and spray assemblies. This equipment is available through a variety of sources.

Installation of steel sheet piling as an operation control during dredging of the Outfall 004 backwater areas would require specialized equipment. Pile driving equipment and the required personnel are available for both land-driven and barge-driven installations.

6.8.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 7 are presented in this Section. A cost sensitivity analysis was performed to evaluate the cost impact associated with use of a single barrier cap over the FSPSA. An appropriate cap would be selected after 10 years of in-situ soil flushing in terms of acceptable risk as described in Sections 4 and 5. The capital costs for each capping alternative is provided in Section 6.8.7.1.

6.8.7.1 Capital Cost

The capital costs for Remedial Alternative 7 are summarized in Table 6-33. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Sitewide Institutional Controls
- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3
- Table 6-6: Unit Costs Utilized for Estimating Containment Costs
- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System
- Table 6-20: Estimated Capital Cost for Solidification Under Remedial Measures FDP-3 and FDP-7
- Table 6-28: Estimated Capital Costs For Thermal Treatment Under Remedial Measure CMSD-7
- Table 6-30: Present Worth of Containment for CMSD Following Thermal Treatment Under Remedial Measure CMSD-7
- Table 6-34: Estimated Capital Costs for Containment under Remedial Alternative 7
- Table 6-35: Present Worth of Containment for FSPSA Following In-Situ Soil Flushing Under Remedial Measure FSPSA-6

TABLE 6-33. Summary of Capital Costs for Sitewide Remedial Alternative 7.

COST ELEMENT	REFERENCE TABLE	ESTIMATED COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment System	6-4	$1,823,000
3. Seep Collection and Treatment System	6-7	$69,550
4. Solidification	6-20	$7,924,380
5. Thermal Treatment	6-29	$68,532,360
6. Future Containing of CMSD {1}	6-30	$436,000
7. Containment	6-34	$2,796,915
8. Future Containing of FSPSA {1}	6-35	$104,112
9. Treatment by In-situ Soil Flushing	6-36	$419,420
10. Treatment by B.E.S.T. Process	6-38	$1,019,300
	SUBTOTAL	$83,206,045
Engineering/Design (10%)		$8,320,605
Installation/Shakedown (5%)		$3,593,182
	SUBTOTAL	$95,119,832
Contingency (20%)		$19,023,966
	SUBTOTAL	$114,143,798
Ground-Water Treatment O&M (years 1-10) {2}	6-10	$5,072,115
	TOTAL {1}	$119,215,913
	ROUND	$119,000,000

{1} Present worth discounted to year 10.
{2} Reflects 10-year present worth factor of 10%.

Revison: 06
December 1, 1993

TABLE 6-34. Estimated Capital Costs for Containment Under Remedial Alternative 7.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATE COST
1. DUAL BARRIER CAPS (FDPs)				
Regrading	74,500	CY	$8.23	$613,135
Membrane (40 mil HDPE)	818,000	SF	$0.50	$409,000
Geonet	818,000	SF	$0.26	$212,680
Geotextile (10 oz.)	818,000	SF	$0.18	$147,240
Clay (Transport)	60,600	CY	$19.00	$1,151,400
Clay (Placement)	60,600	CY	$2.08	$126,048
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$2,692,223
2. CONSOLIDATE CRDA IN CMSD				
Clearing/Grubbing	4.5	acre	$2,800	$12,600
Excavation	5,700	CY	$6.15	$35,055
Borrow (Transport)	3,600	CY	$5.00	$18,000
Borrow (Placement)	3,600	CY	$9.82	$35,352
Hydroseeding	195,000	SF	$0.04	$7,800
			SUBTOTAL	$108,807
			TOTAL {1}	$2,801,030
			ROUND	$2,800,000

{1} Indirect capital costs and contingencies for the containment systems are included in the summary for overall remedial alternatives.

TABLE 6-35. Present Worth of Containment for FSPSA Following In-Situ Soil Flushing Under Remedial Measure FSPSA-6.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
VEGETATED SOIL COVER (FSPSA)				
Fill (Transport)	5,000	CY	$11.36	$56,800
Fill (Placement)	11,200	CY	$2.08	$23,296
Borrow (Transport)	11,300	CY	$5.00	$56,500
Borrow (Placement)	11,300	CY	$9.82	$110,966
Hydroseed	610,000	SF	$0.04	$24,400
			TOTAL	**$271,962**
			ROUND	**$270,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
To Be Constructed in Year 10	$104,112

- Table 6-36: Estimated Capital Costs for In-Situ Soil Flushing Under Remedial Measure FSPSA-6
- Table 6-37: Present Worth for Single Barrier Cap Following In-Situ Soil Flushing Under Remedial Measure FSPSA-6
- Table 6-38: Estimated Capital Costs for B.E.S.T. Solvent Extraction Process, Under Remedial Alternative 7

6.8.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 7 are summarized in Table 6-39 and Table 6-40. The O&M costs for the ground-water extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M Costs for containment systems, thermal treatment and in-situ soil flushing for Remedial Alternative 7 are presented in Tables 6-12, 6-32, and 6-4, respectively.

6.8.7.3 Present Worth

The present worth of Remedial Alternative 7 was calculated to be $124,000,000. This value was calculated in accordance with USEPA guidance[88] utilizing an operating period of 30 years and a discount rate of 10 percent.

[88]USEPA, 1987.

TABLE 6-36. Estimated Capital Costs for In-Situ Soil Flushing Under Remedial Measure FSPSA-6.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1. INFLUENT PIPING				
Excavate/Backfill	1,350	CY	$22	$29,700
Pipe Bedding	450	CY	$29	$13,050
4" Pipe Installation	4,050	LF	$24	$97,200
			SUBTOTAL	$139,950
2. DISTRIBUTION				
Sand Layer	34,500	ton	$6.50	$224,250
Piping	6,200	LF	$4	$24,800
Spray Assemblies	54	each	$180	$9,720
			SUBTOTAL	$258,770
3. EQUIPMENT				
Transfer Pump	1	each	$700	$700
Controls	1	LS	$1,500	$1,500
			SUBTOTAL	$2,200
4. SITE IMPROVEMENTS				
Power Supply	1	LS	$3,000	$3,000
Building	1	LS	$8,000	$8,000
Concrete	25	CY	$300	$7,500
			SUBTOTAL	$18,500
			TOTAL {1}	$419,420
			ROUND	$420,000

{1} Indirect capital costs and contingencies for the soil flushing system are included in the summary for overall remedial alternatives.

TABLE 6-37. Present Worth of Single Barrier Cap for FSPSA Following In-Situ Soil Flushing Under Remedial Measure FSPSA-6.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
SINGLE BARRIER CAP (FSPSA)				
Fill (Transport)	16,300	CY	$11.36	$185,168
Fill (Placement)	22,500	CY	$2.08	$46,800
Membrane (40 mil HDPE)	610,000	SF	$0.50	$305,000
Geonet	610,000	SF	$0.26	$158,600
Geotextile (10 oz.)	1,220,000	SF	$0.18	$219,600
Borrow (Transport)	30,000	CY	$5.00	$150,000
Borrow (Placement)	30,000	CY	$9.82	$294,600
Hydroseed	610,000	SF	$0.04	$24,400
			TOTAL	**$1,384,168**
			ROUND	**$1,400,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
To Be Constructed in Year 10	$539,840

TABLE 6-38. Estimated Capital Costs for B.E.S.T. Solvent Extraction Process Under Remedial Action SED-9.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
Sediment Dredging	2,000	CY	$33	$66,000
Sediment Placement	2,000	CY	$3.10	$6,200
Solvent Extraction	2,000	CY	$350	$700,000
Treated Sediment Placement	2,000	CY	$3.10	$6,200
Residual Liquid Disposal	150	drum	$419.33	$62,900
Temporary Sheet Piling	3,000	SF	$46	$138,000
Silt Curtains	1	LS	$40,000	$40,000
			TOTAL {1}	$1,019,300
			ROUND	$1,000,000

{1} Indirect capital costs and contingencies for the solvent extraction system are included in the summary for overall remedial alternatives.

TABLE 6-39. Summary of O&M Costs for Sitewide Remedial Alternative 7.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
5. In-Situ Soil Flushing	6-40	$4,251
	SUBTOTAL	$965,821
Administration (12%)		$115,899
	SUBTOTAL	$1,081,720
Contingency (20%)		$216,344
	TOTAL	**$1,298,064**
	ROUND	**$1,300,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
30 Year Operation with Ground-Water Treatment	
O&M for Years 1-10 Included in Capital	
Cost of Alternative.	$5,400,000

TABLE 6-40. Estimated Annual O&M Costs for In-Situ Soil Flushing Under Remedial Measure FSPSA-6

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. UTILITIES				
Electricity	65,350	Kwh	$0.06	$3,921
2. MAINTENANCE				
(15% TEC){2}				$330
			TOTAL {3}	$4,251
			ROUND	$4,000

{1} Estimated annual O&M costs for ground-water containment and extraction are included under Table 6-10. Estimated annual flushate treatment costs are also presented in Table 6-10.

{2} Based on Total Equipment Costs ($2,200) per Table 6-36.

{3} Indirect costs and contingencies for O&M of the in-situ soil flushing system are included in the O&M summaries for Remedial Alternatives 7 and 8.

6.9 Remedial Alternative 8

Remedial Alternative 8 constitutes a combined excavation/treatment/containment alternative for the Ormet site. This Alternative was assembled by combining the following remedial measures:

- GW-3: Pumping of Ranney and Existing Interceptor Wells, Treatment of the Interceptor Well Water by Ferrous Salt Precipitation, Clarification, and Discharge to the Ohio River;
- SP-4: Collection of Ballfield and CMSD Seeps Using Trench Drains, Treatment of CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-6: Treatment by In-Situ Soil Flushing, and Containment by Single Synthetic Barrier Cap;
- FDP-5: Containment by Single Barrier Synthetic Cap;
- CMSD-4: Recontouring and Containment by Single Synthetic Barrier Cap;
- CRDA-3: Excavation, Consolidation and Containment by Single Synthetic Barrier Cap; and
- SED-8: Partial Dredging, Solidification, Consolidation with CMSD, and Containment.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.9.

6.9.1 Compliance with ARARs

The ability of Remedial Alternative 8 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.9.1.1 Chemical-Specific ARARs

This remedial alternative would attain chemical-specific ARARs for surface-water discharge using BAT to treat ground water pumped by the existing interceptor wells prior to discharge to the Ohio River. Specifically, effluent from the lime/ferrous salt precipitation treatment system would comply with NPDES effluent limitations currently proposed for the Ormet site. Effluent cyanide concentration reductions were achieved during pilot-scale studies of this technology. Fluoride concentration reductions were also achieved in pilot-scale studies.

Discharge of the treated CMSD seep water would also attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

This remedial alternative could achieve chemical-specific ARARs for aquifer quality. Treatment of the soil in former spent potliner storage area would transfer constituents from the soil into the underlying ground water, where they would be extracted by the interceptor wells. This component of Remedial Alternative 8, coupled with containment of the former disposal ponds and ground-water extraction, could eventually achieve MCLs and MCLGs in the alluvial aquifer.

Remedial Alternative 8 would comply with ARARs for the carbonaceous material in the carbon run-off and deposition area. Under this remedial alternative, these materials would be excavated and consolidated within the CMSD prior to capping of the CMSD. The carbonaceous material in the CRDA is not itself a hazardous waste, therefore, it would not be subject to LDRs as ARARs. The carbonaceous material, which consists primarily of spent anode material (calcined coke), was historically transported into the CRDA by storm water run-on during heavy rainfall. Carbonaceous material identical to that present in the CRDA is routinely sampled to determine whether it exhibits characteristics which would qualify it as a RCRA characteristic waste. This material has never exhibited hazardous characteristics.

6.9.1.2 Location-Specific ARARs

Remedial Alternative 8 would comply with federal and state location-specific ARARs regarding location criteria for solid waste landfills. As identified in Table 1-1, these criteria specify locations in which solid waste landfills are not to be cited, such as floodplains. This ARAR does not require the removal of existing landfills. The 100-year floodplain requirement set forth in OAC 3745-27-07 (A,B) prospectively prohibits the deposition of solid waste in a floodplain. The floodplain requirement is not retrospective, and USEPA guidance recognizes that it is not appropriate to remove large existing landfills from the floodplain[89]. The side slopes of the CMSD bordering the Ohio River and the Outfall 004 backwater area are currently situated within the 100-year floodplain of the Ohio River. The 100-year flood elevation is defined by the Federal Emergency Management Agency (FEMA) as the elevation having a 1% chance of being equaled or exceeded in any given year.

The Floodplain Protection Policies (40 CFR6, Appendix A, and the Fish & Wildlife Coordination Act, 16 USC 661 et seq) are TBCs for the Ormet site. The substantive

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[89]USEPA, 1988d.

requirements of these TBCs are potentially relevant to any activities undertaken by the Federal government.

Under this remedial alternative, the side slopes of the CMSD would be largely removed from the 100-year floodplain by regrading. These actions would be protective of human health and the environment, however a small portion of the material in the CMSD would remain below the 100-year floodplain elevation of 637.5 feet. This 2.5 foot high portion of the CMSD sideslopes would be protected from erosion damage by placement of a riprap barrier along the toe of the CMSD (see Figure 5-9).

6.9.1.3 Action-Specific ARARs

Implementation of this remedial alternative would require attaining a number of action-specific ARARs. Operation of the Ormet Ranney well and the existing interceptor wells would be subject to certain action-specific ARARs under Remedial Alternative 8. Specific maintenance requirements for ground-water casings, pumps, and wells (in general) are set forth in OAC 3745-9-09. Remedial Alternative 8 would comply with these requirements. Ground-water treatment under Remedial Alternative 8 would also be subject to action-specific ARARs. This remedial alternative would comply with any Permits-to-Install (PTI) requirements, as well as operational, maintenance, and monitoring requirements under a NPDES permit.

Off-site landfilling of the ground-water treatment residuals would be subject to action-specific ARARs regarding waste characterization. Remedial Alternative 8 would comply with these requirements. Depending on the outcome of the waste characterization, Remedial Alternative 8 may be subject to various transportation and disposal requirements.

The single barrier synthetic caps that would be constructed over the former disposal ponds and the CMSD would attain or exceed State of Ohio Solid Waste ARARs. As provided under

OAC 3745-27-11(G)(1), the cap designs illustrated in Section 5 would include materials of construction that are comparable to those identified under OAC 3745-27-08 and 3745-27-11.

Capping the CMSD under this remedial alternative would not necessitate explosive gas monitoring because construction materials are generally not putrescible. Wooden scrap that was emplaced in the CMSD is putrescible, however, visual observations during test pit excavation confirmed that this material only makes up a small portion of the CMSD. Furthermore, wooden scrap would not be likely to putrefy at a rate sufficient to generate explosive gases within the CMSD. Air monitoring performed during test pit excavation in the CMSD did not indicate the presence of explosive gases.

Containment measures for the sediments in the Outfall 004 backwater area under this alternative may not attain TBC-based clean-up goals regarding PCBs, depending upon the concentrations of PCBs in the sediments removed from the backwater area. The cleanup goals for PCBs and PAHs that are identified in Appendix F would not be attained by partial dredging of the backwater area. Under this alternative, sediments containing greater than 25 mg/kg PCBs and greater than 370 mg/kg total PAHs would be excavated from the backwater area. The excavated materials from the backwater area would be treated and contained in the CMSD under a single barrier cap. If PCB concentrations exceed 50 mg/kg in the dredged sediment, a TSCA-Complaint cell may need to be constructed in the CMSD. Following removal, the excavated area would be sampled to confirm that the cleanup goals for PCBs and PAHs under this alternative have been achieved.

6.9.2 Overall Protection

The protectiveness of Remedial Alternative 8 for human health and the environment would be very similar to Remedial Alternatives 3 through 7. The potential human health exposure pathways include:

- inhalation of airborne dusts from the former spent potliner storage area and the former disposal ponds;

- ingestion of contaminated media from all areas of concern;

- direct contact with contaminated media from all areas of concern;

These exposure pathways would be effectively addressed under Remedial Alternative 8 for all areas.

6.9.3 Short-Term Effectiveness

This remedial alternative would be protective of human health and the environment in the short-term. The short-term effectiveness associated with implementation of Remedial Alternative 8 is described in the following sections.

6.9.3.1 Time Until Protection is Achieved

The protection associated with Remedial Alternative 8 could be achievable within ten years following remedy selection. Once the containment structures under this remedial alternative are constructed, the remedial action objectives would be achieved by blocking direct exposure pathways of inhalation and ingestion. Containment of the ground-water plume would be achieved immediately because pumping of the Ormet Ranney well and the existing interceptor wells represents current conditions. Effective treatment of the extracted ground water from the interceptor wells would be achievable pending construction and shakedown of the required treatment system and equipment. The timeframe for this component of Remedial Alternative 8 includes 19 months engineering design and construction following the issuance of a permit to install.

The implementation time for in-situ flushing of the soils in the former spent potliner storage area is not known due to the relatively limited information on this technology. Under this alternative, it has been assumed that the soil flushing system would operate for a period of 10 years. The actual implementation time would be indicated by asymptotic decreases in monitoring parameters.

Some of the elements of this remedial alternative could potentially achieve protection within a very short timeframe. Collection and treatment of the CMSD seeps falls within this category. In consideration of the relative simplicity of the treatment system for the CMSD seeps, design and implementation of the collection trench and treatment equipment for the CMSD seeps could be potentially completed within 1 to 2 years. Furthermore, it is possible that the seeps would eventually disappear following capping of the CMSD.

Administrative requirements concerning dredging activities under this remedial alternative may extend the timeframe for achieving protection. The extent of this increase in the time required for implementation is not known, but may be on the order of one to three years.

Remedial Alternative 8 involves several containment structures including single barrier caps, steel sheet piling, and concrete revetments. These structures could be constructed within 2 to 3 years. The estimated construction time for capping was developed assuming sequential capping of the former disposal ponds, the CMSD, and the containment of Outfall 004 backwater area sediments.

6.9.3.2 Short-Term Reliability

Remedial Alternative 8 would be reliable within the short-term. Containment of the ground-water plume would be performed through continued pumping of the Ormet Ranney well (installed in 1958) and the existing interceptor wells (installed in 1972). These wells have operated reliably since their installation and would continue to do so under this remedial alternative. The Ormet Ranney well is equipped with three 150 HP pumps and the interceptor wells are each equipped with a 25 HP submersible pump. Under normal operations, one of the pumps in the Ormet Ranney well and one of the interceptor wells are operated. Therefore, the ground-water containment system currently has in-line redundancy to ensure reliable, continuous operation.

Treatment of the interceptor well water under this remedial alternative would not be performed in the short-term. As discussed in Section 6.9.3.1, approximately 19 months (after issuance of the PTI) will be required for construction of a treatment system under this alternative. Therefore, ground-water treatment would be initiated in the mid-term, and would continue over the long-term. The reliability of the ground-water treatment component of this alternative is addressed in Section 6.9.4.3.

Containment of the former disposal ponds, the CMSD, and the Outfall 004 backwater sediments would not be performed in the short-term. As discussed in Section 6.9.3.1, approximately 2 to 3 years will be required for containment of these areas. Therefore, containment of these areas would be initiated in the mid-term, and would continue over the long-term. The reliability of this component of Remedial Alternative 8 is addressed in Section 6.9.4.3.

6.9.3.3 Community Protection

Implementation of this remedial alternative would not adversely impact the health or safety of the community during the construction period. The containment components of Remedial Alternative 8 will require regrading of the CMSD and the former disposal ponds. Additionally, the sediments in the Outfall 004 backwater area would be dredged and the carbonaceous materials in the CRDA would be excavated and placed under the cap in the CMSD. These earthmoving activities could potentially result in airborne emissions of dust and other substances. However, as discussed in Section 4, these emissions would be effectively controlled through application of dust suppressants such as water, anhydrous calcium chloride, or foam.

Under this remedial alternative, ground water extracted by the interceptor wells would continue to be discharged to the Ohio River via Outfall 004, pending construction of a treatment system. These activities would not adversely impact the community over the short-term because river water in this area is not used for drinking purposes and recreational uses in the vicinity of the site are minimal. Additionally, bioassay testing of the Outfall 004 water, which includes untreated ground water extracted by the existing interceptor wells demonstrated that this water is not acutely toxic to aquatic organisms.

There is no possibility that implementation of this alternative would generate toxic gases. Ground-water treatment would be performed at alkaline pH, therefore, the generation of HCN gas is not possible. None of the other treatment or containment components of this alternative would result in the possible generation of toxic reaction by-products.

6.9.3.4 Worker Protection

Implementation of Remedial Alternative 8 would be protective of workers involved in remedial construction activities. Workers associated with remedial construction activities under this alternative would require training and medical monitoring in accordance with 29 CFR 1910.120. Additionally, these workers would be required to utilize protective clothing and respiratory equipment as specified in a site-specific health and safety plan. Operational controls (i.e., work zones, decontamination facilities, air monitoring, etc.) would be established to further protect workers during the construction period.

Dust suppressants would be used during the excavation of the CRDA to restrict fugitive dust emissions. Partial dredging of the Outfall 004 backwater sediments is not expected to generate significant dust unless the sediments are allowed to dry, at which point dust suppressants may also be used on the sediments. Given the use of dust suppressants during the excavation of the CRDA the amount of dust possibly generated cannot be estimated, but inhalation exposure during the periods of excavation and transfer are expected to be minimal. Appropriate protective equipment would be utilized during the period of excavation and material handling to provide additional protection of the workers.

6.9.3.5 Environmental Impacts

Construction of the various components of this remedial alternative will result in short-term environmental impacts at the site, which may include the following:

- Disruption of natural drainage patterns;
- Generation of dust and noise;
- Increased sediment runoff;
- Installation of temporary roads and utilities;
- Resuspension of sediments; and

- Construction of temporary staging and vehicle maintenance areas.

These impacts will be minimized through the use of standard construction and engineering practices, including the use of runon-runoff controls, silt fences and sedimentation basins, dust suppresants, silt curtains, and general good housekeeping practices. The actual measures to be taken to address potential environmental impacts during remedy construction will be determined during remedial design. The costs associated with these measures have been factored into the estimated cost for this remedial alternative.

Sediments in the Ohio River would be addressed through natural processes. Elimination of the potential for future releases from the backwater area and natural sedimentation over the existing sediments would combine to reduce the potential hazards to aquatic life in the river. As discussed previously, resedimentation is expected to be a relatively rapid process due to the site setting.

6.9.4 Long-Term Effectiveness

This remedial alternative would also be protective of human health and the environment over the long-term. The long-term effectiveness that would result from implementation of Remedial Alternative 8 is evaluated in the following sections.

Ground-water remediation and aquifer restoration at the Ormet site will be a long-term program, probably in terms of decades. This remedial alternative includes ground-water remedial measure GW-3, which consists of pumping of the Ormet Ranney well and existing interceptor wells to control and recover the plume, followed by treatment of the extracted ground water using BAT prior to discharge to the Ohio River. Although at this point in time, an exact prediction of the duration of ground-water remediation is not possible, estimates of the timeframe required to accomplish aquifer restoration can be refined as the remedial program progresses. Over the past 9 years of monitoring, the available data indicate that there has already been an improvement in the quality of ground water pumped from the interceptor well system (see Appendix A). Continued operation of the interceptor well system will result in further water-quality improvements over time. To facilitate the comparison of alternatives presented in this FS, the time that may be required to reduce the concentration of total cyanide in that portion of the alluvial aquifer immediately downgradient of the FSPSA to 0.1 mg/L has been roughly projected to be 38 years under current site conditions. A more detailed discussion of the calculations, data, and assumptions used to project reductions in cyanide concentrations is provided in Appendix K. Soil flushing of the FSPSA under Remedial Alternative 8 is expected to decrease this timeframe. This is due to the enhanced leaching of constituents in the unsaturated zone, resulting in a more rapid transfer of contaminants from the unsaturated soils to the ground-water system. Due to the uncertainties regarding the effectiveness of the soil flushing, the extent to which the aquifer restoration time can be reduced by soil flushing of the FSPSA cannot be reliably predicted.

This alternative would be effective in reducing the infiltration of precipitation through the soils of the former spent potliner storage area, the solids in the former disposal ponds, and the wastes in the CMSD. Regrading of the site and construction of the single barrier synthetic caps would promote run-off and evapotranspiration. Infiltration modelling was performed for the single barrier synthetic caps (see Appendices I and J). For the FSPSA, regrading and construction of the single barrier synthetic cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to approximately a 99.5 percent decrease in infiltration over existing conditions. For the CMSD, regrading and construction of a single barrier cap would only allow 0.17 percent of the incident precipitation to infiltrate. This equates to a 99.4 percent reduction over existing conditions. Based on these results, leachate generation in these areas would be virtually eliminated.

6.9.4.1 Reduction of Assumed Existing Risks

Similar to Remedial Alternative 2, implementation of Remedial Alternative 8 would reduce the existing human health and environmental risks (as assumed in the Baseline Risk Assessment) by addressing the potential for exposure. Exposure to the constituents detected in the affected media would be eliminated by the construction of the single barrier caps. Direct contact with the media beneath the caps would be precluded and emission of fugitive dust would not occur. There would be no exposure to the impacted media beneath the single barrier caps, therefore, the risks would be zero.

Ground-water risks were not identified as an existing risk at the site. Pumping of the existing interceptor wells and treatment of the captured ground-water would continue to prevent current exposure to the ground water beneath the site. This system is equally effective in addressing the constituents detected in the ground water from past releases from the site, as well as any additional leaching that might occur through the single barrier cap.

Collection of the seep water in the trenches and discharge to the Ohio River following treatment, if necessary, to acceptable discharge levels would preclude exposure to the seep waters by trespassers or terrestrial animals. The exposure pathways for the seep waters would be eliminated, therefore, the risks associated with the seep waters would be zero.

Partial dredging of the Outfall 004 backwater area to remove constituents, followed by placement of concrete revetments over the remaining sediments would prevent direct exposure to constituents in sediments and prevent future releases from the backwater area to the river. Concrete revetments would prevent erosion and block direct exposure to the dried sediments that would remain in this area. Human exposure to the sediments beneath the revetments would be precluded by the size and weight of the revetments. The human exposure pathways to the backwater sediments would be eliminated, therefore, the risks would be zero. Exposure of fish in the Ohio River from these sediments would also be eliminated. Therefore, the risk to humans associated with the ingestion of fish that may have bioaccumulated constituents from the Ormet site would be zero.

Constituent concentrations in the sediments of the Ohio River are expected to decline as the Outfall 004 backwater area is partially dredged and contained with the concrete revetments, and as natural sedimentation processes cover up the impacted sediments. Relatively rapid sedimentation is consistent with the fact that the site is located on the inside of a meander in the river and the river currents adjacent to the site would be less than elsewhere in the river channel. Furthermore, the site is situated upstream of the Hannibal Lock and Dam and as such, the large quantity of water pooled behind the dam would promote siltation. Therefore, the risks for a trespasser are expected to decrease over time as the sediments are covered by background river sediments. Constituents in the Outfall 004 backwater area would be removed or contained beneath the concrete revetments, therefore, the risk values in the baseline risk assessment would no longer be appropriate.

6.9.4.2 Magnitude of Future Risks

Similar to Remedial Alternative 2, constituents in the alluvial ground water would be collected and treated under Remedial Alternative 8. Future hypothetical exposure of plant worker, maintenance workers, and residents to the ground water by ingestion would be precluded by the containment and treatment of the ground water extracted by the interceptor wells, and by the establishment of a deed restriction on the property that would preclude use of contaminated ground water as a source of potable water.

Treated water would be discharged to the Ohio River. The iron to cyanide ratio of 25:1, as proposed for GW-3, reduces cyanide and fluoride without posing an acute toxicity hazard to the aquatic biota. This was evidenced by the acute toxicity data discussed in Section 4 and Appendix A.

Trench drains would effectively collect seeps at the ballfield and the CMSD. Future exposure of child and adult residents to the seep water would be eliminated by these actions.

Pumping and treatment of the impacted ground water, collection of the seep water in trench drains, combined with the deed restrictions on future land use would effectively eliminate the potential for future exposure of plant workers, maintenance workers, and residents by ingestion of the constituents in the ground water. This would include eliminating the potential for exposure to any constituents that might still leach from the underlying media after the caps are installed. Therefore, in the absence of an exposure pathway, the potential future risks associated with the ground water are zero.

Single barrier caps on the former spent potliner storage area, the former disposal ponds, and the CMSD (with the consolidated carbonaceous material from the carbon run-off and deposition area and the dredged sediments) would prevent the emission of fugitive dust and eliminate direct contact exposure to the impacted media. The single barrier caps over these areas would preclude future exposure by inhalation of the constituents and would thereby eliminate future risks to humans or terrestrial wildlife. The single barrier caps form a physical barrier that would preclude phytotoxicity to all but the deepest rooting plants such as trees. An aspect of the maintenance of the single barrier caps would include control of burrowing animals through baiting and removal of seedling trees that might take root at the site. Infiltration through the single barrier caps could mobilize some of the constituents in the underlying media, however, as discussed in the preceding paragraph, these constituents would pose zero risks to humans or wildlife.

Because the 004 backwater area is an embayment of the Ohio River, relocation of the 004 outfall stream prior to sediment removal and placement of revetments would not eliminate benthic habitat. Sediment removal and placement of revetments would temporarily disrupt the benthic habitat in the backwater area. However, because the backwater area is an embayment, resedimentation and the associated restoration of benthic habitat would occur relatively rapidly.

Studies performed by the U.S. Army Corps of Engineers (1991) indicate that in-situ capping can be an effective method of providing long-term isolation of contaminated sediments. The overall effect of these actions would be that exposure to constituents in the backwater area would be eliminated or greatly reduced. Food chain exposures associated with the Outfall 004 backwater area would also be essentially eliminated. Partial dredging of the Outfall 004 backwater area and placement of concrete revetments would eliminate the potential for future releases to the Ohio River, and natural sedimentation processes in the river would cover the impacted sediments with background river sediments. Therefore, the potential for direct exposure and aquatic food chain exposure would decrease as the depth of background river sediments covering the impacted sediments increases.

In summary, the remedial measures that comprise Remedial Alternative 8 would eliminate or significantly reduce the potential for exposure, and the potential future risks to humans and the environment would be reduced to acceptable levels.

6.9.4.3 Long-Term Reliability

Remedial Alternative 8 would be reliable over the long-term. As discussed in Section 6.9.3.2, containment of the ground-water plume through continued pumping of the Ormet Ranney well and the existing interceptor wells has performed reliably since installation of these wells. In consideration of the in-line redundancy in the ground-water extraction system, ground-water containment over the long-term is expected to be highly reliable.

The long-term reliability of in-situ soil flushing is not known due to the fact that this technology has not been applied over the long-term at other sites. The systems for conveyance and application of the flushing water are relatively simple and are therefore expected to be reliable over the long-term. The long-term reliability of this component of Remedial Alternative 8 could be decreased by channelling effects in the soil. If preferential flow paths (or channels) are established in the soils, localized volumes of soil may not be contacted by the flushing water. This effect would result in reduced ability to remove soluble constituents from the soils reliably over the long-term. However, given the nature and texture of the soils that are predominant beneath the former spent potliner storage area (i.,e., sands and gravels), channeling effects may be limited. These effects may be further limited by the method of applying water to the soils that would be employed under this remedial alternative. Spray application would facilitate even distribution of water across the surface of the former spent potliner storage area.

Long-term reliability of single barrier caps utilizing synthetic membrane materials of construction has been proven, dependent upon adequate post-closure maintenance. Caps employing these materials of construction are susceptible to punctures, tears, and freezing temperatures, mainly during construction. Proper QA/QC during cap installation can greatly reduce the potential for damage to the cap. Standard engineering practice of installing geotextile fabric between the vegetated layer and drainage layer, coupled with vegetating the cover with grasses that do not have deep roots, will aid in preventing root penetration. Animals that currently live on-site would be controlled prior to capping (OAC 3745-27-11 (G)(4)). The geotextile fabric and geonet will also aid in preventing the animals from burrowing into the cap. A well-maintained vegetative cover, periodic inspections and limited site access will ensure reliable long-term performance of the single barrier caps. Synthetic membranes exhibit a high degree of resistance to chemical contact and are capable of elongating up to 500 percent (National Sanitation Foundation Standard Number 54). Unless atypical settlement or depressions develop, the integrity of a synthetic membrane cap will not be comprised by settlement.

Treatment of the interceptor well water under this remedial alternative would also be reliable over the long-term. Pilot studies have demonstrated that precipitation using lime and ferrous salts is a complex process requiring careful process control.[90] Operational variability was found to be common during the pilot studies, apparently due to the complicated precipitation chemistry for cyanide complexes. The equipment that would be utilized under this remedial alternative could be reliably maintained and operated over the long-term.

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[90]Baker/TSA, Inc. 1990.

Vendor literature indicates that materials used for concrete revetments are reliable over the long-term. The fabric envelope is immune to attack by mild acids and alkalis, organic solvents and biological organisms. The current of the river will not adversely impact the revetments. Therefore, concrete revetments would be reliable over the long-term.

CERCLA requires a five year review whenever the selected remedy will leave wastes on site above levels that allow for unlimited use and unrestricted exposure. Under this alternative, wastes will be left on site; therefore, a five year review would be required.

6.9.4.4 Prevention of Future Exposure

As discussed previously, pumping of the Ormet Ranney well and the interceptor wells will effectively contain the ground water plume under the Ormet site. Treatment of the ground water extracted by the interceptor wells by precipitation using lime/ferrous salts will reduce constituent concentrations in the extracted ground water to levels that will be acceptable for discharge to the Ohio River under NPDES permit requirements. Trench drains would effectively collect the seep water and eliminate possible exposure at the ballfield or CMSD seeps. As discussed in Section 6.9.4, regarding the remediation of ground water, restoration of ground-water quality will require an extended period of time. Therefore, under the hypothetical future residential use scenario evaluated in the BRA, there would be a potential for exposure to contaminated ground water through an on-site drinking water well until restoration of the aquifer is achieved. Institutional controls could be imposed to prevent future residential use of the property.

The single barrier synthetic caps that would be provided over the CMSD and the former disposal ponds under this remedial alternative can effectively eliminate infiltration and transport of constituents from these areas. Additionally, the sand layer utilized during flushing and the future vegetated soil cover that would be placed over the former spent potliner storage area following completion of in-situ flushing would eliminate short-term and long-term future potential exposures.

Pumping and treating of the alluvial ground water, capping with single barrier synthetic caps, and concrete revetments over the Outfall 004 backwater area sediments will eliminate direct contact exposure, prevent releases to the air, and significantly reduce the potential for infiltration and transport of constituents to the ground water. Therefore, Remedial Alternative 8 will eliminate or significantly reduce future exposure to the constituents present at the Ormet site.

6.9.4.5 Potential for Replacement

Due to the high degree of long-term reliability for the ground-water extraction and treatment components of this remedial alternative, the potential need to replace these components over the long-term is low. Additionally, the potential need to replace the components associated with the in-situ soil flushing system is low due to the relative simplicity of the equipment that would be employed. Similarly, the highly durable materials utilized in concrete revetments would not be likely to require replacement over the long-term. Potential for repair of single barrier caps utilizing synthetic membrane materials of construction will be limited to periodic maintenance of the soil cover. Periodic maintenance would include checking perimeter fencing, checking for soil subsidence and erosion, control of burrowing animals (OAC 3745-27-11 (G)(4)), and removal of trees. Proper site inspection, maintenance, and security would serve to reduce the potential for more extensive repair or replacement of the cap components.

6.9.5 Reduction of Mobility, Toxicity, and Volume

This remedial alternative would result in removal of constituents for the ground water extracted by the interceptor wells, as well as for the CMSD seeps. No volume reductions would result from implementation of Remedial Alternative 8. The mobility of the various organic and inorganic constituents present in the various media at the site would not be reduced under this remedial alternative, although the containment barriers that would be provided under Remedial Alternative 8 would effectively block transport pathways.

6.9.5.1 Quantities Treated or Destroyed

Ground water extracted by the interceptor wells is one of three media that would undergo treatment or destruction under this remedial alternative. As discussed in Section 2, the quantity of ground water extracted by the interceptor wells is approximately 0.34 MGD (124 million gallons per year).

Based on the estimated maximum seep flowrate of 5 gpm, the total quantity of seep water that would be collected under this remedial alternative is less than 2.7 million gallons per year. Assuming that 50 percent of this water emanates from the seeps along the toe of the CMSD, the total quantity of seep water that would undergo treatment under this alternative is approximately 1.3 million gallons per year. Furthermore, it is possible that the seeps would eventually disappear after the capping of the CMSD.

The total volume of soil in the former spent potliner storage area would be treated by in-situ flushing under this remedial alternative. Approximately 800,000 cubic yards of soil would be treated by in-situ flushing under this alternative.

6.9.5.2 Degree of Expected Reductions

Treatment of the ground-water extracted by the interceptor wells has been shown to remove cyanide, fluoride, and color. As discussed in Section 3.2.3.3, influent cyanide concentrations of 5.5 to 9.6 mg/L were reduced under carefully controlled pilot plant operations to effluent concentrations of 0.19 to 0.89 mg/L[91]. This corresponds to a cyanide removal efficiency of 90.7 to 96.5 percent. Influent fluoride concentrations of 24 to 34 mg/L were reduced under a carefully controlled pilot plant conditions to 10 to 15 mg/L[92]. This

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[91]Baker/TSA, Inc., 1990.

[92]Baker/TSA, Inc., 1990.

corresponds to a fluoride removal efficiency in the range of 55 to 58 percent. Color removal was determined qualitatively by visual observation. Tea-colored influent was associated with a clear effluent.

Under this remedial alternative, oil present in the CMSD seeps would be removed by oil/water separation. Vendor literature indicates that effluent oil and grease concentrations of 10 mg/L are achievable. Dissolved PCBs, if any, present in the separator effluent would be removed by activated carbon adsorption. Activated carbon is highly efficient for removing PCBs.

The degree of expected reductions in constituent concentrations that would result form in-situ flushing of the soils in the former spent potliner storage area is not known due to the limited data available on this technology. Studies have shown that in-situ soil flushing is most effective would occur in highly permeable soils with low organic content. Based on the RI report, the former spent potliner storage area may meet these criteria. Therefore, this technology may result in significant reductions for soluble soil constituents.

In utilizing a single barrier cap over the CMSD coupled with regrading, infiltration would be reduced thus eliminating or significantly decreasing generation of the seeps. Following capping, the seeps may stop discharging entirely.

6.9.5.3 Permanence of Treatment

Cyanide and fluoride precipitation utilized in the ground-water treatment system is a permanent treatment. The cyanide and fluoride would be precipitated into a sludge and the sludge would be removed from the system and disposed off-site.

Treatment of the CMSD seeps by oil/water separation is also a permanent treatment. The treatment residuals from this treatment process would include free-phase oil and spent activated carbon that may contain PCBs.

6.9.5.4 Treatment Residuals

Treatment residuals would be generated by treatment of the extracted flushates resulting from in-situ flushing of the former spent potliner storage area. These treatment residuals consist of dewatered sludge resulting from the precipitation process. Baker/TSA, Inc. estimated that full scale operation would yield approximately three tons per day of dewatered sludge (filter cake)[93]. Samples of the sludge from the pilot plant were collected and analyzed for reactive cyanide and EP Toxicity. This testing showed that the sludge was not a characteristic hazardous waste[94].

Treatment residuals would also be associated with treatment of the collected seep water from the CMSD seeps. These residuals would include free-phase oil from the oil/water separator and spent activated carbon from the adsorber vessels. The amount of free-phase oil observed on the CMSD seeps during the RI was limited to a light sheen. Consequently, the amount of oil resulting from implementation of this alternative would be minimal. As discussed in Section 5, it was assumed that three containers of activated carbon would be expended quarterly. This equates to approximately 4,800 pounds per year (at 400 pounds per container).

Solidification of the sediments from Outfall 004 backwater area will also generate treatment residuals. The solidified material will increase from 25 to 75 percent by volume, resulting in 1,300 to 1,800 CY (Table 6-13).

[93]Baker/TSA, Inc., 1990.

[94]Baker/TSA, Inc., 1990.

6.9.6 Implementability

Remedial Alternative 8 is potentially implementable within site conditions.

6.9.6.1 Constructability and Operability

This remedial alternative is operable within site conditions but poses certain constructability problems. The Ormet site is an operating industrial facility with an established and well trained security and maintenance force. Accordingly, the Ormet site is well suited to ensure proper security, maintenance and operation of the various components of this remedial alternative. There are no construction considerations for the ground-water containment system because the Ormet Ranney well and the interceptor wells are existing features on-site. Construction of the ground-water treatment equipment for the lime/ferrous salt precipitation system would not be hindered or adversely impacted by existing conditions on-site. Construction of collection trenches for the CMSD and ballfield seeps would involve relatively shallow excavation depths and could be accomplished using commonly available heavy equipment. Treatability studies would be performed to determine the actual carbon usage for removing dissolved organics from the seeps.

As discussed in Section 6.9.3.2, the ground-water extraction system has been operated reliably since installation of the Ormet Ranney well and the existing interceptor wells. This has required periodic maintenance of the pumps and wells to ensure proper operation.

Pilot studies have demonstrated that treatment of the ground water extracted by the interceptor wells requires careful process control[95]. Operational variability was found to be common during the pilot studies due to the complex chemistry involved in cyanide precipitation.

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[95]Baker/TSA, Inc., 1990.

Subsequent pilot studies demonstrated that the lime/ferrous salt precipitation process can be operated within the design/operating conditions.

Construction of single barrier caps utilizing synthetic membrane as the barrier layer would require specialized equipment for welding the seams of the membrane. This equipment would be utilized under the supervision of a qualified specialty installer. Construction of single barrier caps over the former disposal ponds would not pose undue engineering difficulties under this remedial alternative. Due to the fluidity of the underlying pond solids, the use of heavy equipment would need to be limited to prevent liquefaction of the crustal layer.

Treatability studies would be required to show the level of removal that is achievable for implementing soil flushing in the former spent potliner storage area. Bench scale and field studies would need to be performed on a plot at the site.

The sediments from the Outfall 004 backwater area could potentially be dredged in the following manner. A crawler-mounted clamshell could be maneuvered to the toe of the CMSD. This equipment would dredge the sediments from the Outfall 004 backwater area and place them on top of the CMSD for drying and solidification. Once situated on top of the CMSD, earthmoving equipment could be utilized to solidify the sediments with lime and flyash. Treatability studies would be performed to determine the proper mixing ratio of sediments with the solidification reagents.

There are no operability considerations associated with the containment components of Remedial Alternative 8. However, periodic inspection of the containment structures would be required. Repairs could be performed if so indicated by these inspections.

6.9.6.2 Ability to Phase Into Operable Units

The component remedial measures that constitute Remedial Alternative 8 provide certain opportunities for phasing remediation of the Ormet site in operable units. For example, the following elements of Remedial Alternative 8 could be managed as operable units:

- ground-water extraction and treatment;
- seep collection and treatment;
- soil treatment; and
- containment measures.

Several of these component remedial measures must be implemented sequentially. For example, construction of the ground-water treatment must precede in-situ soil flushing under this alternative because soil flushing will utilize the treated effluent as the flushing solution.

6.9.6.3 Ability to Monitor Effectiveness

The short-term and long-term effectiveness associated with implementation of Remedial Alternative 8 could be effectively monitored through use of the existing network of ground-water monitoring wells. These wells could be used for periodic ground-water level measurements to confirm that the ground-water extraction system continues to contain the plume on-site. These wells would also be effective for periodic sampling to monitor plume distribution and constituent concentrations. Additionally, these wells could be used to monitor the effectiveness of the in-situ soil flushing system in the former spent potliner storage area. Periodic ground-water quality data will also provide the best means of adjusting projects of the time required to achieve reductions in contaminant concentrations.

Cap inspections would be performed to monitor the integrity of the cap barrier. Inspections would include checking for differential settlement or soil subsidence, erosion, leachate outbreaks, surface water ponding and stressed vegetation.

The collection trenches for the CMSD and ballfield seeps would provide an opportunity to effectively monitor the flowrate of the seeps. Additionally, the discharge from the ballfield collection trench and the CMSD seep treatment system would be utilized effectively to monitor the chemical composition and concentrations of the discharges.

Periodic inspections of the concrete revetments would be performed to ensure that no shifting or cracking of the revetment has occurred. No sediment sampling will be performed.

Additional remedial action could be instituted if monitoring indicates that such actions are needed. The former disposal ponds, CMSD, and CRDA would not pose a problem, since these areas would be contained with no treatment. Additional remedial actions for ground water, seeps, and former spent potliner storage area would require modifications to the treatment systems. Changes of this nature would be difficult to implement. Sediments would be dredged for consolidation within the CMSD and stabilized, which would result in increased volume. Thus, further remedial action on the treated sediments would be difficult.

6.9.6.4 Ability to Obtain Approvals

Certain approvals would be required for implementation of Remedial Alternative 8. Approvals would be required for construction of the ground-water treatment system for the interceptor well water that is included in this remedial alternative. Approval to construct this system would be in the form of a Permit-to-Install. Similarly, a PTI may be required for the CMSD seep collection and treatment system, and the ballfield seep collection system. Approvals would also be required for discharges to surface-water under the NPDES program. The NPDES permit for the Ormet facility will govern discharges to surface water under this remedial alternative. Pursuant to the terms of an easement granted to the United States, approvals may be necessary from the U.S. Army Corps of Engineers (USACOE) prior to any bank improvements involving any dredge or fill activities along the edge of the Ohio River and the Outfall 004 backwater area.

6.9.6.5 Availability of Off-Site Services and Capacity

Off-site transportation and disposal services would be required for the treatment residuals discussed in Section 6.9.5.4. Under this remedial alternative, the sludge resulting from the lime/ferrous salt precipitation process would be handled by off-site landfilling. The required transportation and disposal services for these residuals exist within USEPA Region V[96]. Adequate disposal capacity is commercially available for these materials.

Free-phase oil, if any, resulting from treatment of the CMSD seeps would be handled by off-site facilities. Due to the potential presence of PCBs in the oil, it has been assumed that the oil would be treated by incineration. The required transportation and disposal services for the oil exist within USEPA Region V[97]. Adequate disposal capacity is commercially available.

Spent activated carbon resulting from treatment of the CMSD seeps would also be handled by off-site facilities under Remedial Alternative 8. Due to the relatively small quantity of spent carbon, regeneration is not feasible for this material. Commercial suppliers of activated carbon were contacted regarding the availability of regeneration services for carbon that would contain PCBs. These services do not exist. Consequently, the spent activated carbon would be managed by off-site landfill disposal or thermal treatment. The required transportation and disposal services are available. Adequate disposal capacity is also available for the spent activated carbon.

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[96]USEPA, et. al., 1990.

[97]USEPA, et. al., 1990.

6.9.6.6 Availability of Equipment and Specialists

Skilled workers and specialized equipment are not required for the ground-water extraction and treatment components of this remedial alternative. However, trained operators would be required for the ground-water treatment equipment, as well as the CMSD seep treatment system.

Specialized equipment and skilled workers would be required for installation of the single barrier caps under this remedial alternative. However, the required materials and services are available through a variety of commercial sources.

Skilled workers and specialized equipment would not be required for implementation of the in-situ soil flushing component of Remedial Alternative 8. The equipment required for this system includes a transfer pump and spray assemblies. This equipment is available through a variety of sources.

Skilled workers and specialized equipment would not be required for installation of concrete revetments over the sediments in the Outfall 004 backwater area. Installation of steel sheet piling as an operational control during dredging of the Outfall 004 backwater area would require specialized equipment. Pile driving equipment and the required personnel are available for both land-driven and barge-driven installations.

6.9.7 Cost

The capital and O&M costs that would be incurred through implementation of Remedial Alternative 8 are presented in this Section.

6.9.7.1 Capital Cost

The capital costs for Remedial Alternative 8 are summarized in Table 6-41. Details regarding the capital costs for various components of this remedial alternative are provided in the following tables:

- Table 6-3: Estimated Capital Costs for Sitewide Institutional Controls
- Table 6-4: Estimated Capital Costs for Ground-Water Treatment System Under Remedial Measure GW-3
- Table 6-6: Unit Costs Utilized for Estimating Containment Costs
- Table 6-7: Estimated Capital Costs for Seep Collection and Treatment System
- Table 6-16: Estimated Capital Costs for Sediment Dredging and Solidification Under Remedial Measure SED-8
- Table 6-35: Present Worth of Containment System for FSPSA Following In-situ Soil Flushing Under Remedial Measure FSPSA-6
- Table 6-36: Estimated Capital Cost for In-Situ Soil Flushing Under Remedial Measure FSPSA-6
- Table 6-42: Estimated Capital Costs for Containment Under Remedial Alternative 8

6.9.7.2 Operating and Maintenance Costs

The operating and maintenance costs that would be incurred through implementation of Remedial Alternative 8 are summarized in Table 6-43. The O&M costs for the ground-water

TABLE 6-41. Summary of Capital Costs for Sitewide Remedial Alternative 8.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-3	$81,008
2. Ground-water Treatment	6-4	$1,823,000
3. Seep Collection and Treatment System	6-7	$69,550
4. Sediment Dredging	6-16	$224,000
5. Future Containment of FSPSA{1}	6-37	$539,840
6. In-Situ Soil Flushing	6-36	$419,420
7. Containment	6-42	$3,293,474
	SUBTOTAL	$6,450,292
Engineering/Design (10%)		$645,029
Installation/Shakedown (5%)		$115,599
	SUBTOTAL	$7,210,920
Contingency (20%)		$1,442,184
	SUBTOTAL	$8,653,104
Ground-Water Treatment O&M (years 1-10) {2}	6-10	$5,072,115
	TOTAL {1}	$13,725,219
	ROUND	$14,000,000

{1} Present worth discounted to year 10.
{2} Reflects 10-year present worth at 10%.

TABLE 6-42. Estimated Capital Costs for Containment Under Remedial Alternative 8.

COST ELEMENT	ESTIMATED QUANTITY	UNIT	UNIT COST	ESTIMATED COST
1. CONCRETE REVETMENTS	13,500	SF	$4.00	$54,000
2. SINGLE BARRIER CAP (CMSD)				
Fill (Placement)	5,000	CY	$2.08	$10,400
Grading	90,000	CY	$8.23	$740,700
Membrane (40 mil HDPE)	270,000	SF	$0.50	$135,000
Geonet	270,000	SF	$0.26	$70,200
Geotextile (10 oz.)	540,000	SF	$0.18	$97,200
Borrow (Transport)	13,000	CY	$5.00	$65,000
Borrow (Placement)	13,000	CY	$9.82	$127,660
Rip-Rap	860	SY	$31.85	$27,391
Hydroseeding	270,000	SF	$0.04	$10,800
			SUBTOTAL	$1,338,351
3. SINGLE BARRIER CAPS (FDPs)				
Fill (Transport)	21,700	CY	$17.04	$369,768
Fill (Placement)	43,750	CY	$2.08	$91,000
Membrane (40 mil HDPE)	818,000	SF	$0.50	$409,000
Geonet	818,000	SF	$0.26	$212,680
Geotextile (10 oz.)	818,000	SF	$0.18	$147,240
Borrow (Transport)	39,400	CY	$5.00	$197,000
Borrow (Placement)	39,400	CY	$9.82	$386,908
Hydroseed	818,000	SF	$0.04	$32,720
			SUBTOTAL	$1,846,316
5. CONSOLIDATE CRDA IN CMSD				
Clearing/Grubbing	4.5	acre	$2,800	$12,600
Excavation	5,700	CY	$6.15	$35,055
Borrow (Transport)	3,600	CY	$5.00	$18,000
Borrow (Placement)	3,600	CY	$9.82	$35,352
Hydroseeding	195,000	SF	$0.04	$7,800
			SUBTOTAL	$108,807
			TOTAL {1}	**$3,293,474**
			ROUND	**$3,300,000**

{1} Indirect capital costs and contingencies for the containment systems are included in the summary for overall remedial alternatives.

TABLE 6-43. Summary of O&M Costs for Sitewide Remedial Alternative 8.

COST ELEMENT	REFERENCE TABLE	ESTIMATED ANNUAL COST
1. Sitewide Institutional Controls	6-9	$28,325
2. Ground-water Treatment	6-10	$825,459
3. Seep Collection and Treatment System	6-11	$19,786
4. Containment	6-12	$88,000
5. In-Situ Soil Flushing	6-39	$4,251
	SUBTOTAL	$965,821
Administration (12%)		$115,899
	SUBTOTAL	$1,081,720
Contingency (20%)		$216,344
	TOTAL	**$1,298,064**
	ROUND	**$1,300,000**

TOTAL PRESENT WORTH (10% PRESENT WORTH FACTOR)	
30 Year Operation with Ground-Water Treatment O&M for Years 1-10 Included in Capital Cost of Alternative.	$5,400,000

extraction and treatment components of this remedial alternative are summarized in Table 6-10. The O&M costs for collection and treatment of the CMSD seeps are presented in Table 6-11. O&M costs associated with the containment components of Remedial Alternative 8 are presented in Table 6-12. O&M costs for in-situ soil flushing are presented in Table 6-40.

6.9.7.3 Present Worth

The present worth of Remedial Alternative 8 was calculated to be $19,400,000. This value was calculated in accordance with USEPA guidance[98] utilizing an operating period of 30 years and a discount rate of 10 percent.

6.10 Remedial Alternative 9

Remedial Alternative 9 constitutes a combined excavation/treatment/off-site disposal alternative for the Ormet site. Remedial Alternative 9 was assembled by combining the following remedial measures:

- GW-5: Pumping of Ranney, and New Interceptor Wells, Treatment of the New Interceptor Well Water by Ferrous Salt Precipitation, Clarification, Post-Treatment by Activated Alumina Adsorption, and Discharge to the Ohio River;
- SP-4: Collection of the Ballfield and CMSD Seeps Using Trench Drains, Treatment of the CMSD Seeps by Oil/Water Separation and/or Carbon Adsorption;
- FSPSA-9: Partial Excavation with Off-Site Landfilling of the Excavated Soils and Containment by Single Barrier Synthetic Cap;
- FDP-7: Solidification and Containment by Dual Barrier Cap;

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[98]USEPA, 1987.

- CMSD-7: Complete Excavation, Treatment by Thermal Oxidation, and Containment by Single Barrier Synthetic Cap;
- CRDA-4: Excavation with Off-Site Landfilling of the Excavated Material; and
- SED-4: Complete Dredging, Solidification, and Off-Site Landfilling of the Dredged Sediments.

Details regarding the component remedial measures that were assembled to form this remedial alternative are discussed in Section 5.10.

6.10.1 Compliance with ARARs

The ability of Remedial Alternative 9 to comply with chemical-, location-, and action-specific ARARs established for the Ormet site is evaluated in this Section.

6.10.1.1 Chemical-Specific ARARs

The ability of this remedial alternative to attain chemical-specific ARARs for surface-water, using BAT to treat ground water pumped by the new interceptor wells located closer to the source, prior to discharge to the Ohio River is uncertain. Effluent cyanide and fluoride concentration reductions were achieved during pilot-scale studies of the lime/ferrous salt precipitation treatment system using ground water pumped from the existing interceptor wells. Extensive pilot-scale testing would be required to evaluate the effectiveness of this treatment process using ground water pumped from wells closer to the source. Post-treatment by activated alumina adsorption could reduce fluoride concentrations further, although the extent of these reductions is not known.

Discharge of the treated CMSD seep water would attain chemical-specific ARARs for surface water discharge. The parameters addressed in the NPDES effluent limits currently proposed for the Ormet site would not be exceeded by the CMSD seeps. This is evidenced by the seep quality data obtained during the RI. In the event that the effluent from the seep collection and treatment systems exceeds the NPDES discharge limits, these residuals could undergo further treatment using BAT prior to discharge if necessary.

This remedial alternative could achieve chemical-specific ARARs for aquifer quality. Excavation of an area of greater relative cyanide concentration and containment of the former spent potliner storage area, treatment and containment of the former disposal ponds, and ground-water extraction could eventually achieve MCLs and MCLGs in the alluvial aquifer.

Remedial Alternative 9 would also be subject to various relevant and appropriate chemical-specific requirements. Thermal treatment of the materials contained within the CMSD would be subject to the following requirements:

- OAC 3745-17-02(A,B,C): Establishes specific standards for total suspended particulate emissions.
- OAC 3745-17-05: Sets forth the non-degradation policy for particulate.
- OAC 3745-17-07(A-D): Specifies the allowable opacity for visible particulate emission.
- OAC 3745-17-09(A,B,C): Establishes particulate emission limitations and odor restrictions for incinerators.
- OAC 3745-18-06(A-G): Establishes limitations for sulfur dioxide emissions.
- OAC 3745-21-08(A-E): Establishes requirements for minimization of carbon monoxide emissions from stationary sources.